

The Sphaeriidae of Australia

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ABSTRACT

A revision of the Australian freshwater mussels of the Sphaeriidae (Mollusca, Bivalvia) is given. The author distinguishes 12 species, 5 belonging to the genus *Sphaerium* Scopoli and 7 to the genus *Pisidium* C. Pfeiffer. With the exception of the cosmopolitan *P. casertanum* (Poli), all are Australian endemics. One species of *Sphaerium* (*kendricki*) and three of *Pisidium* (*aslini*, *fultoni* and *hallae*) are new to science. Lectotypes are selected of *Sphaerina nundinalis* Iredale, *Australpera mena* Iredale and *Pisidium etheridgei* Smith.

Species concepts within the Sphaeriidae and problems of their subgeneric classification are discussed. The subgenera *Afropisidium* Kuiper and *Odhneripisidium* Kuiper are relatively sharply defined, morphologically as well as zoogeographically. Lectotypes of *P.(A.) gundlachi* Arango and *P.(A.) consanguineum* Prime, both from Cuba, and earlier selected by Dr. C. Meier-Brook without publication, are designated. *Afropisidium*, represented in Australia by *P. aslini*, possibly has a Gondwanic origin. The Eurasian *Odhneripisidium* is not known from Australia, but may eventually be found in tropical Australia.

Cyclas australis Lamarck and *Pisidium semen* Menke, originally described as Sphaeriidae, belong to the marine Leptonidae. Lectotypes of both are designated and figured.

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1. INTRODUCTION

The small freshwater mussels belonging to the Sphaeriidae are distributed all over the world. The main genera, *Sphaerium* and *Pisidium*, both in the wider sense, are equally cosmopolitan. Their centre of evolution lies doubtlessly in the Holarctic Region. The oldest pisidia I have had the opportunity to examine are from the Palaeocene in North Dakota, North America, and the Eocene in France, but the origin of *Pisidium* is certainly Mesozoic.

Among taxonomists the Sphaeriidae are notorious for the scarcity of well definable and measurable specific characters, conchologically as well as anatomically. The variability of the group is comparatively very limited. Shape and hinge structure for example, are less variable than those of the big freshwater clams, the Unionidae. The sculpture of the Sphaeriidae is poor compared to that of the Thiaridae. The colour of the shell is monotonous in comparison with the range of colours and patterns in freshwater gastropods like the Neritidae. The differences are still more striking when the variability of the Sphaeriidae is compared with that of marine groups like the Cardiidae, the Muricidae (sculpture), the Conidae and Cypraeidae (colours and patterns) etc.

Within the narrow variation observed within a genus, however, several species, especially of the genus *Pisidium*, are relatively polymorphic. The absence of measurable characters in many species and frequent overlapping of shell-characters often result in convergence not reflecting phylogenetic relationships – hence, the inevitable esotericism of many descriptions. Woodward (1913) offers an example of it. In his compilation of Latin diagnoses he uses no less than 15 different terms to define the shape of the shell of pisidia, six terms for the specific differences of sculpture and another six for the insignificant tones of colours. Sixteen different terms were used to describe the shape of the beaks viz., obtusus, obtusiusculus, obtusissimus, prominens obtusissimus, prominens, vix prominens, rotundatoprominens, prominens latus rotundatus, validus latus rotundatus, prominulus, subprominulus, parum prominulus, acutisculus, prominens acutiusculus, subacutiusculus, interdum subacutus, subdepressus. It goes without saying that even semantically skilled malacologists are not able to find their way through this terminological labyrinth, without good illustrative support and well identified comparative specimens to hand. As a matter of fact, identification keys and descriptions are only used with full certainty in this group by those experienced workers who do not need them anymore. Convergence not only leads to errors in identification but, also, as recent literature shows, in attempts at subgeneric division of pisidia.

These introductory remarks do not aim to discourage the study of sphaeriid taxonomy. They rather will warn against the risk of unjustified simplification. In his excellent little book the well-known author Ellis (1978: 49) notes in passing: "If pea cockles were as large as marine cockles they would present little difficulty", reducing thus the difficulties of identification to a question of magnification. I do not agree with this view, for all species of the Cardiidae (marine cockles) have measurable characters in their sculpture, besides their characteristic shape and colours. Even were they as small as Sphaeriidae (pea cockles), this particularity would remain.

In spite of the fluctuating variability many species of Sphaeriidae have proved to be clear biological realities. Their identification is not a question of personal taste or philosophy, nor of intuition, but of careful morphological comparison of large series, from juvenile to adult and from as many localities as possible. When I started studying Australian

Sphaeriidae some 25 years ago, examining nearly all material accessible at that time, I arrived at the conclusion that Australia must be the poorest continent with respect to the sphaeriid fauna. However, the result of more intensive field collecting, mainly in Tasmania, Victoria and New South Wales, has changed my opinion in the last decade. Now after closing the manuscript of this monographic study, I admit that taxonomically the last word on the Australian Sphaeriidae has not yet been said. It seems possible that still more species will be discovered and that zoogeographical surprises may occur.

It is now the task of the Australian field workers to continue collecting large series in all kinds of freshwater basins, type-localities included, in order to enable taxonomists to verify my species concept in this matter and to arrive at a better understanding of the degree of variation of each species. Further, it is necessary to define the ecological and distribution patterns, altimetric and bathymetric patterns included, and to study the fascinating problem whether or not subspecies of *Pisidium* and *Sphaerium* may be distinguished in Australia. Finally, we must verify if, or to what extent, the distribution factors discussed in section 5 are valid in Australia too. As long as such problems have not been solved, it is important to lodge specimens of each record, accurately labelled, in at least one of the public collections of Australia.

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3. ABBREVIATIONS USED IN THE SYSTEMATIC PART

3.1. Public collections.

AMS = Australian Museum, Sydney; BML = British Museum (Natural History), London; FMC = Field Museum of Natural History, Chicago; IFC = Inland Fisheries Commission, Hobart; MCZ = Museum of Comparative Zoology at Harvard College, Cambridge, Mass., U.S.A.; MHNP = Muséum National d'Histoire Naturelle, Paris; MUC = Monash University, Zoology Department, Clayton, Victoria; NMV = National Museum of Victoria, Melbourne; QM = Queensland Museum, Gregory Terrace; RML = Rijksmuseum van Natuurlijke Historie, Leiden; SAM = South Australian Museum, Adelaide; SMF = Senckenberg-Museum, Frankfurt am Main; TMH = Tasmanian Museum, Hobart; USNM = United States National Museum, Washington, D.C.; UTH = University of Tasmania, Zoology Department, Hobart; WAM = Western Australian Museum, Perth; ZMA = Instituut voor Taxonomische Zoölogie & Zoölogisch Museum, Amsterdam (K = the author's collection); ZMZ = Zoologisches Museum der Universität Zürich.

3.2. Field collectors

Abr = L. Abrahams; Adc = D.J. Adcock; All = P. Allbrook; Arc = M. Archer; Art = A.H. Arthington; Asl = F.W. Aslin; Ban = T.L. Bancroft; Bar = L. Barraclough; Bra = J. Brazier; Cla = T.W.H. Clarke; Cle = W.B. Clarke; Cog = J. Collin; Col = F.S. Colliver; Com = D. Coleman; Coe = D. Coolen; Cot = B.C. Cotton; Cox = G. Cox; Dar = A.J. Dartnall; Dav = G. & C. Davis; Edw = D. Edward; Eth = R.E. Etheridge; Eva = J.W. Evans; Ful = W. Fulton; Gab = C.J. Gabriel; Gom = M. Goman; Gra = M. Gray; Gre = J.F. Greenhill; Gru = F.L. Grutzmacher; Hal = S.J. Hall; Han = K. Handley; Har = P. Harvey; Hed = C. Hedley; Hel = R. Helms; Hoe = D. Hoese; Jef = E. Jefferys; Joh = R.M. Johnston; Ker = J. Kerslake; Kig = C.D. King; Kin = P.G. King; Kng = R.L. King; Lak = P.S. Lake; Loc = I. Loch; Mca = J. McAuley; Mcl = D.F. McMichael; Mcm = N. McMillan; Mcw = P. McWilliams; Mei = C. Meier Brook; Mol = B.C. Mollison; Mui = B. Muir; Mur = L. Murray; Nei = C. Neil; Nor = R.H. Norris; Pax = J. Paxton; Pet = W.F. Petterd; Pla = R. Plant; Pon = W.F. Ponder; Pri = G.B. Pritchard; Ric = A. Richardson; Ros = S.W. Rosso; Shi = I. Shirley; Sle = A. Sloane; Slo = R. Sloane; Smh = B.G. Smith; Smi = B.J. Smith; Ste = T. Steel; Swa = R. Swain; Taf = Taffin; Ten = J.E. Tenison Woods; Tim = B.V. Timms; Tuc = R. Tucker; Tyl = W. Tyler; Wal = C. Wallace; Wha = W.T. Whan; Whi = G.P. Whitley; Wig = E.R. Wiggins; Zei = W. Zeidler.

4. HISTORY OF SPHAERIID RESEARCH IN AUSTRALIA

The first "sphaeriids" reported from Australia, *Cyclas australis* Lamarck, 1818, and *Pisidium semen* Menke, 1843, are not freshwater bivalves, but, as shown in section 9, marine and brackish water species not belonging to the Sphaeriidae.

Gould (1846: 794) published a real sphaeriid from Australia, viz., *Cyclas egregia*. This species, discovered by an American expedition in the Hunter River, has never been recorded since. Smith (1883) considered this a *Sphaerium*, of which the exact type-locality is not known, "doubtfully Australian".

It was Tenison Woods (1876) who practically laid the basis of our knowledge of the Australian sphaeriids by publishing three species from Tasmania, viz., *Pisidium tasmanicum*, *Pisidium dulvertonensis* (which has proved to be a *Sphaerium*), and *Cyclas tasmanica* (which is a *Sphaerium* too).

Sowerby (1876, pl. 5, f. 46) figured the new *Sphaerium translucidum* and Smith (1883: 305) added two other new species of *Sphaerium* to the Australian fauna viz., *S. queenslandicum* and *S. macgillivrayi*, as well as the first real *Pisidium* from the Australian continent, *P. etheridgei*, collected in the Yan-Yean Reservoir, Plenty District, Victoria.

Chapman (1914: 56) published Pleistocene records of Australian sphaeriids. He identified them as *S. tasmanicum*, in the synonymy of which he placed *S. macgillivrayi* Smith.

Cotton & Godfrey (1938: 178) published *Sphaerium tatariae* from South Australia and Gabriel (1939: 128) *Sphaerium problematicum*, from Victoria.

It is not surprising that former workers, not specialized in this group and knowing nothing about the variation margin of the Australian sphaeriids, preferred to publish, perhaps tentatively, new species rather than speculating in placing the new forms within the variation of already known species. That must have been the reason why Iredale, impressed by the fact that British authors had already recognized 17 good species of *Pisidium* in Great Britain only, and considering that "it might take a century to discriminate the Australian forms", concluded "The most we can do at present is to catalogue the species geographically, and hope someone will later undertake the elucidation of the group" (Iredale, 1943a: 195). Starting from this point of view, he created several only slightly differing "species". As a working method this may be acceptable under the following conditions: (1) that large series from each locality are studied, (2) that clear descriptions and accurate figures are published, (3) that the respective type-localities are indicated exactly with as many topographical and ecological details as possible, (4) finally, that type-specimens are lodged in several public collections in order to make them accessible to future workers. Unfortunately, Iredale fulfilled these conditions only minimally, complicating thus more than facilitating the study of this group. His descriptions are absent or incomplete, the indication of type-localities is not sufficiently detailed, and figures are lacking. Iredale (1943a: 195, 1943b: 94) in this way added seven new species of Sphaeriidae to the Australian fauna viz., *Sphaerinova terenda*, *Sphaerinova victoriana*, *Sphaerinova lacusedes*, *Sphaerinova nundinalis*, *Australpera mena*, *Australpera bradena*, and *Glacipisum kosciusko*.

Cotton (1953: 21), described *Sphaerinova bursa* and *Australpera cara* from South Australia and, as far as I know, no new Australian sphaeriids have been published since.

Most of these species are based on one or a few specimens only. Methodical collecting of sphaeriids with appropriate means was apparently not yet practised. Only in the last ten years field collectors have given more attention to this neglected group of bivalves. Fulton explored lakes of Tasmania, Ponder and his team did fine work in the mountains of New South Wales and in Tasmania, Timms dredged in the tarns of the Snowy Mountains, Lake and his students, as well as Aslin and many others collected fine series of sphaeriids, making evident that these small clams are common and widely distributed over most of Australia.

The present paper reduces the number of already published species to eight and adds four new species, so that the total number of Australian sphaeriid species comes now to 12. With the exception of the cosmopolitan *P. casertanum*, all are endemic to Australia.

Some forms which I am not yet able to identify are kept in my files until more material is available.

5. SPECIES AND SUBSPECIES CONCEPTS IN SPHAERIIDAE

The history of malacology shows that the species concept has known some modifications. This is also the case with the Sphaeriidae.

In the middle of the 19th century several European malacologists thought that each water basin has its own species of *Pisidium*. In France it was the early student in *Pisidium*, Gassies¹, who reflected this view. In central Europe Clessin (1887-1890), whose identifications have widely penetrated the malacological literature, practised nearly the same ideas. Underestimation of specific variability and of the possibility of passive dispersal as well as ignorance of the possibility of self-fertilization of *Pisidium* influenced the species concept.

In the second half of the 19th century, the so-called "Nouvelle Ecole" (= new school) with malacologists like Bourguignat, Locard, Servain and others (Kuiper, 1969; Dance, 1970) postulated that the species in malacology is an artificial product of the human mind, not an objective reality. In their view the species is a fiction (Locard, 1884). According to the Nouvelle Ecole, all so-called species of Mollusca are morphologically connected by intermediate forms depending on environmental conditions. This philosophy, inspired by the transformism of Lamarck (1809)², opened the way to creation of an endless number of new species. Hundreds of species of najades, lymnaeids, prosobranchs, etc. were published by the scholars of the Nouvelle Ecole. In the field of the small freshwater bivalves, however, the Nouvelle Ecole, which recognized the authority of Baudon (1857), was more reserved. Nevertheless, the number of names of species, varieties and forms constantly increased. Clessin (1879) published a list of all species known in the genus *Pisidium* and arrived at the number of 57. Paetel (1890) listed 112 known species and many varieties. Actually I have far more than 1000 published names in my files. The real number of recent species of *Pisidium* in the world is, in my opinion, approximately 80 and will probably not exceed 100, that of *Sphaerium* perhaps not more than 50.

The Swiss Victor Sterki, who at the end of the 19th century emigrated to the United States where he continued Temple Prime's basic work on North American sphaeriid systematics (Johnson, 1959), introduced the narrow European species concept into the New World. In his preliminary catalogue Sterki (1916) listed some 220 Nearctic species and varieties of Sphaeriidae. His descriptions are detailed and he often mentioned several localities of each new species. However, he omitted designation of type-localities; types were not selected either. Unfortunately, possibly due to the former policy of *The Nautilus*, in which journal most of his new species were published, Sterki rarely added figures. Sterki and his many correspondents³ often succeeded in collecting large series, but his species concept in the field of Sphaeriidae remained narrow. Thanks to the Canadian Herrington (1962) the study of this group in North America was again placed on a firm basis by synonymizing a great number of Sterki's names; however since, in my opinion, Herrington had a tendency to "lump", some fundamental work in sphaeriid taxonomy has

¹Gassies, 1849: 209. "Ce genre nouvellement distrait des Cyclades par Pfeiffer, est excessivement nombreux en espèces; chaque mare, fossé, canal, ruisseau ou rivière apporte son contingent au groupe déjà nombreux des espèces connues".

²Lamarck, 1809: 58 "..... plus nos collections s'enrichissent, plus nous rencontrons des preuves que tout est plus ou moins nuancé, que les différences remarquables s'évanouissent, et que le plus souvent la nature ne laisse à notre disposition pour établir des distinctions, que des particularités minutieuses et, en quelque sorte puériles". "..... ces espèces se confondent,, les unes avec les autres."

³The following merit special mention: J.A. Allan, W.J. Clench, M.H. Dall, C.C. Engberg, J. Eyerdam, G.H. Handwerk, J.B. Henderson, A.A. Hinkley, R.J. Kirkland, F.R. Latchford, N.W. Lermond, G.H. Marston, O.O. Nylander, H.A. Pilsbry, P.B. Randolph, E.W. Roper, H.E. Sargent, G.J. Streator, L.H. Streng, B. Walker.

still to be done in North America. Burch (1975), in his compact, well-illustrated survey of North American Sphaeriidae arrived at a total number of 38 species.

The first half of the 20th century was in Europe a time of critical revision and of synonymizing by authors like Johansen, Woodward, Odhner, Stelfox, Oldham, Favre and others. They clarified the systematic inheritance of the 19th century, bringing also other than pure conchological elements into their considerations, e.g. anatomical and ecological arguments. Modern collecting techniques have made it possible to take large series from each locality and consequently to obtain a wider view on the variability of species. Examining great numbers of specimens from all parts of Europe, these authors successively reduced the number of species considerably, putting many names into the synonymy. A major obstacle in this work was the irreparable loss of types by acts of war.

Iredale's species making in the field of Australian sphaeriids was not backed by a kind of philosophy. It was merely a working method. Each of his "new species" had the value of a hypothesis.

In the last two decades a new species concept is gaining ground in eastern Europe. The Leningrad School guided by the dynamic malacologist Starobogatov and with scholars like Streletzkaia, Kutikova, Pirogov, Timm, the late Mordukhai-Boltovskoi, and Krivosheina, considers each of the "traditional" western European species to consist of a group of "small species". The traditional species obtain the status of subgenera. The Soviet taxonomists attach primary diagnostic importance to the dentition as well as to the convexity of the shell and to the curve of the frontal part of valves, juvenile as well as adult. The dentition has subgeneric value. They argue that each "small species" has its particular ecological requirements and its zoogeographical identity. For generic division the finer structure of the ligament is important. Forms with different growth and reproduction rates in different conditions have to be considered, according to the Leningrad School, different small species. Consequently, recent species of *Sphaerium* and *Pisidium* cannot have lived in the Pliocene for reasons of different climate. In case of conchological similarity of recent and fossil forms we should have to consider the latter separate "small species". The number of "small species" thus discerned is a multiple of those recognized by the traditional workers. According to Scarlato (1981: 173) the total number of small species of Sphaeriidae in the USSR is expected to amount to between 200 and 500. The future will tell whether this revolutionary new system will stand.

The fundamental question is: are there any objective norms of specific distinction in Sphaeriidae or is it merely a question of personal taste? A subordinate question is: do there exist any solid arguments for distinction of geographical subspecies in the traditional species?

Although personal interpretation of observations is unavoidable, sometimes statistical differences do exist. In the Holarctic Region species distinction is facilitated by the fact that very often several species of Sphaeriidae live in the same habitat, thus undergoing similar environmental influences. In central European lakes it is possible to collect up to ten associated species. Frequently the number of specimens is several thousands, sometimes even 10,000 or more per square meter. Much greater densities have been reported in unispecific gatherings. Hinz (1977) registered 51,000 to 76,500 living individuals of *S. corneum* per square meter in a pond-outlet. Sandusky & Sparks (1979) reported 100,000 individuals of *Musculium transversum* per square meter in a pond⁴. In multispecific

⁴Little is known on population densities of sphaeriids in Australia. Timms (1980: 172) records about 3000 individuals per square meter at a depth of 8.5 m in the Lake Albina, Snowy Mts, N.S.W., which seems to be exceptional.

gatherings the species are more or less clearly separated from another by morphometric gaps. These gaps, which facilitate identification, are, when repeatedly found, an objective norm for specific distinctness. In some cases of similar species such gaps are measurable and statistically demonstrable. The latter is the case with the often associated European species *P. milium* Held and *P. pseudosphaerium* Schlesch. The frequency curves of their relative convexity show two tops (Kuiper, 1949). However, morphometric gaps do not always indicate specific distinctness. Such gaps in populations may also be caused by seasonal or ecological influences or by successive generations (Holopainen & Kuiper, 1982).

The difficulty in the identification of the sphaeriids in the Southern Hemisphere is the fact that associations of two or more species of the same genus are rare. Australia is no exception to this rule. In Australia series of Sphaeriidae I found just one species of each genus, rarely two. The shell may vary slightly from one locality to another. Here it becomes arbitrary to decide whether one has to do with distinct species or merely with forms of the same species. In such circumstances the tendency to split is dominant, especially when the series are numerically poor. My own opinion is then supported by my experiences in the Northern Hemisphere, summarized as follows.

(1) Passive dispersal. Sphaeriids have frequent possibilities of passive migration from one water body to another, even from one river system to another over mountains and seas. They are carried by insects, birds, amphibians, and fish. A resting *Pisidium* or *Sphaerium* keeps its valves slightly gaping. When the mantle is touched by a tarsus or an antenna of a beetle, or a feather of a diving bird, the mollusc quickly closes its valves. From that very moment it is the captive of its own protective reaction and may remain closed for several hours or even days. Big waterbeetles (*Dytiscus*) have been seen flying with one or more pisidia attached to their feet (Kew, 1893; Fernando, 1954; Rees, 1965; Kuiper, 1976; Mackie, 1979). In this way pisidia are transported to other water basins, even when remote and isolated. In my opinion and in that of many European workers, this is also the way by which pisidia colonize postglacial tarns in the Alps (Zschokke, 1900; Odhner, 1929; Kuiper, 1974). It is probable that the chances of passive dispersal are not the same for all species and in all ecological circumstances. Shadin (1935) supposes that species living in stagnant water have more chances of passive transportation than those of streams. Populations on the bottom of deep lakes are possibly more isolated in this respect than those living in the littoral zone.

(2) Absence of isolation. Passive dispersal neutralizes to a certain degree geographical isolation, which is generally considered a condition of speciation. Hence, the absence or scarcity of geographical subspecies or races (Kuiper, 1982). Heard (1962), although admitting the importance of passive dispersal, emphasizes nevertheless, that watersheds may be barriers in the migration of certain species of *Pisidium*. Clinal variation, common in land snails, is not known to me in Sphaeriidae. Nearly all European species of Sphaeriidae are geographically widely distributed, several of them being Palaearctic or even Holarctic.

Endemic Holarctic Sphaeriidae with a limited distribution are rare. Such species are only known from some old Tertiary lakes, viz., *P. edlaueri* Kuiper in Lake Ohrid, *P. raddei* Dybowski in Lake Baikal, Siberia, *P. korotnewi* Lindholm in the same lake, or as relics of a formerly larger area viz., *P. ultramontanum* Prime, in parts of California and Oregon, U.S.A. (Taylor, 1960). Discontinuity in space and time is, with many other freshwater organisms, a normal phenomenon in the distribution of Sphaeriidae.

(3) Self-fertilization. Sphaeriidae are hermaphroditic. Cross-fertilization is doubtless normal in dense populations. In less favourable conditions, however, the chance of self-fertilization increases. This way of reproduction has been observed in the laboratory (Odhner, 1951: 27; Heard, 1965: 401; Meier-Brook, 1970: 83). One individual may produce up to 20 or more offspring at a time. In favourable conditions there are two new generations a year. Just one gravid individual dropped anywhere in a suitable body of freshwater is capable of founding a new population within a couple of years, especially in the absence of predators.

(4) Resistance to dryness and tolerance to changes of water temperature. With closed valves several species of sphaeriids are able to withstand incidental environmental dryness rather well (Adensamer, 1934; Zeissler, 1960; Combes & al., 1971; Hinz, 1972; Danneel & Hinz, 1974). Moreover, some species tolerate quick changes of water temperature. Adensamer (1934) reports water temperatures of 20°C at day time, and about 0°C at night in some high mountain tarns in Austria. In shallow water at an elevation of 2000 m in the Eastern Pyrenees, *P. casertanum* supports daily temperature fluctuations of twenty degrees centigrade (Stefano, 1969: 34). It is able to survive in European alpine lakes covered with ice during eleven months a year (Zschokke, 1900: 36).

(5) Presence in different climatic belts. Most European species are eurythermic and widely distributed. Their area of distribution often comprises one or two continents and different climatic belts. Species like *P. nitidum*, *P. milium*, *P. subtruncatum*, and *P. casertanum* occur not only within the Scandinavian sector of the Arctic Circle, but also in the subtropical climate of North Africa. For this reason it is not surprising to find them as fossils in Pliocene deposits too.

(6) Alti- and bathymetric occurrence. In Europe, no endemic high mountain species of *Pisidium* is known to exist. Nine species of *Pisidium* have been recorded from an elevation of 1000 up to 2800 m (Kuiper, 1974). The number of associated species decreases with increasing altitude. These nine species each have a wide distribution in the lower zones and in the plains. The many thousands of high mountain tarns in the Alps and the Pyrenees are all of postglacial age. Apparently, conditions favourable to speciation, time included, are lacking. Small local morphological differences even between populations may be observed, but there is, in my opinion, no reason to distinguish subspecies or (micro-)geographical races in the Alps and the Pyrenees. The same is the case with the Scandinavian mountains which are partially situated within the Arctic Circle. Some cold-stenothermal, originally Asiatic species, viz., *Sphaerium nitidum* Clessin, *Pisidium hinzi* K., *P. waldeni* K. (Kuiper, 1975) have migrated to Scandinavia in postglacial times. In deep lakes most of the pisidia live in the littoral and sublittoral zones, down to about 30 m. In greater depths, down to 350 m, at most two stenothermal species occur, viz., *P. personatum* (which has a wide distribution in Europe where it is a common species in cold springs) and *P. conventus* (which is discontinuously distributed in the European boreo-subalpine zones). Again, there are here no endemic species at all. In this connection attention is drawn to the fact that in African high mountain tarns with exceptional ecological conditions, forms of *Pisidium* not known at lower altitudes have been recorded viz., *P. artifex* K. and *P. montigenum* K. (Kuiper, 1966a; Löffler, 1968).

(7) Fossil sphaeriids. Fossil pisidia are known from as early as the Palaeocene of North America, viz., *P. wardensis* and *P. russelli* (Bickel, 1973) and the Eocene of France, viz., *P. mausseneti* (Laub.) and *P. ellipsoidale* (Coss.) (Cossmann, 1886). These forms are at first glance recognizable as representatives of the genus *Pisidium* with a normally situated

ligament-pit (fig. 5b). Speciation in this conservative group apparently takes a very long time. "New" species originating only from ephemeral waters like ponds and geologically young lakes in well explored regions are therefore suspect in advance.

Taking the above mentioned factors into consideration, it is clear that there is hardly room for genesis of subspecies or geographical races. The viewpoint that practically each separated population might represent an incipient subspecies is, in my opinion, not correct. Only when all populations of a given region appear to differ morphologically from those of another region, may the distinction of geographical races be considered. It is evident that intensive and methodical field-collecting has to precede such conclusions.

6. GENERIC, SUBGENERIC AND ZOOGEOGRAPHICAL NOTES

The genera *Sphaerium* Scopoli and *Pisidium* C. Pfr. are hermaphroditic and ovoviviparous. Their anatomical organization (gills, nephridia) as well as the structure of the hinge are similar; both have two adductor muscles, a lower posterior and a higher inserted anterior one. *Sphaerium* has two siphons, partially or totally fused, the lower (branchial) being longer than the upper (anal), and two gills on each side, the outer (posterior) gill smaller than the inner (anterior) one. *Pisidium*, on the other hand, has either two siphonal apertures and two gills on each side, or just one aperture and one gill, the posterior being completely reduced. Conchologically, *Sphaerium* is distinguished from *Pisidium* by its generally larger shell. Its length varies from 1.5 mm, juvenile, to 20 mm, adult (in Australia up to 9.5 mm). The shell-length of *Pisidium* varies from about 1 mm (juvenile) to 14 mm (in Australia up to 5 mm). In *Sphaerium* shells the back part is more produced than the front part, the beaks are somewhat prosogyrous. In *Pisidium* it is the front part which is more produced than the back part, whereas the beaks are postmedian and somewhat opisthogyrous (fig. 9). Juvenile shells of *Sphaerium* resemble adult *Pisidium*. Some training is needed to separate them. There is no norm for adulthood in the shell of Sphaeriidae. Long before being full-grown, species of *Sphaerium* and *Pisidium* are sexually mature and capable of reproduction. The discrepancy between physiological and morphological maturity is striking in this group.

Most authors consider *Sphaerium* and *Pisidium* as belonging to just one family, the Sphaeriidae, sometimes called Pisidiidae (Starobogatov, 1977). Others, following the general trend of raising systematic rank, prefer to classify them into two subfamilies, the Sphaeriinae and the Pisidiinae (Baker, 1927; Clarke, 1981), or even into two families, the Sphaeriidae and the Pisidiidae (Bowden & Heppell, 1966; Ellis, 1978). There are arguments pro and contra. For practical reasons mainly I regard *Sphaerium* and *Pisidium* as genera of one and the same family, the Sphaeriidae Jeffreys, 1862.

Subgeneric division of both genera is often arbitrary, especially in *Pisidium*. The subgenera of *Sphaerium* are generally based on shell characters, the position of the ligament included, partially also on embryological (Heard, 1964) or electrophoretic arguments (Hornbach et al., 1980). A biogeographical postulate that each continent has its own subgeneric units, is tacitly adopted by most authors.

The almost chaotic situation in the subgeneric classification of *Pisidium* appears plainly in Boettger's (1961, 1962) study. Bowden & Heppell (1968: 239, 257), followed by other European authors, therefore did not use subgeneric names arguing: "For a limited

[geographical] area we are able to construct a more or less satisfactory subdivision, but as soon as we confront this system with species from other continents, we feel its inadequacy and the arbitrariness of the subgeneric characters chosen". In America, Heard (1977: 453) arrives at a similar conclusion: "It is difficult at this time to recognize the phylogenetic relations within the Sphaeriidae because anatomies, life histories and fossil records are still poorly known in several groups". It is for the same reasons that I have not yet made an attempt to classify the Australian species of *Pisidium* with subgenera, with the exception of *P. aslini*. Generic or subgeneric names like *Australpera* Iredale, 1943 (type-species: *P. etheridgei* Smith), and *Glacipisum* Iredale, 1943 (type-species: *Glacipisum kosciusko* Iredale), are scientifically unsatisfactory, but they are valid according to the rules of zoological nomenclature.

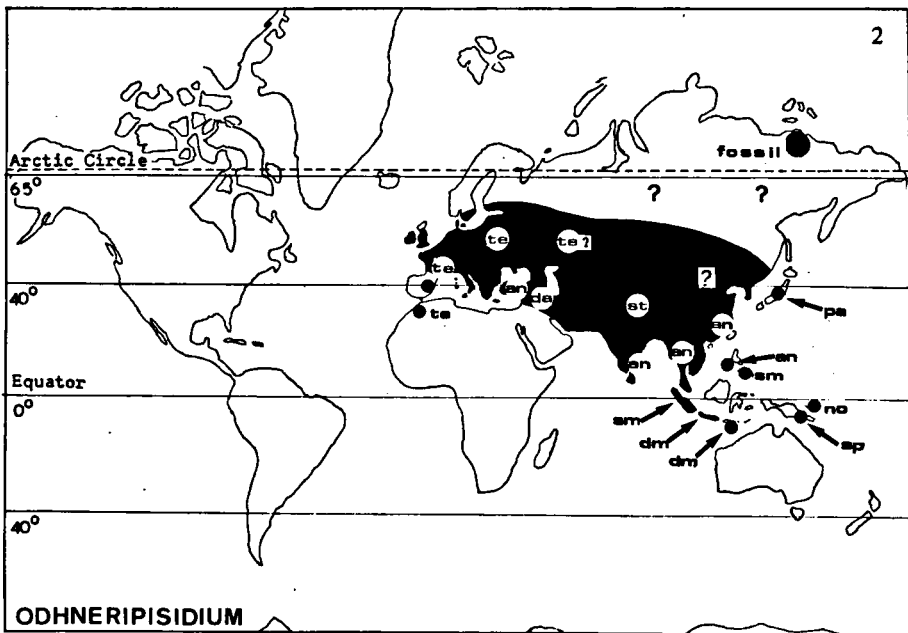
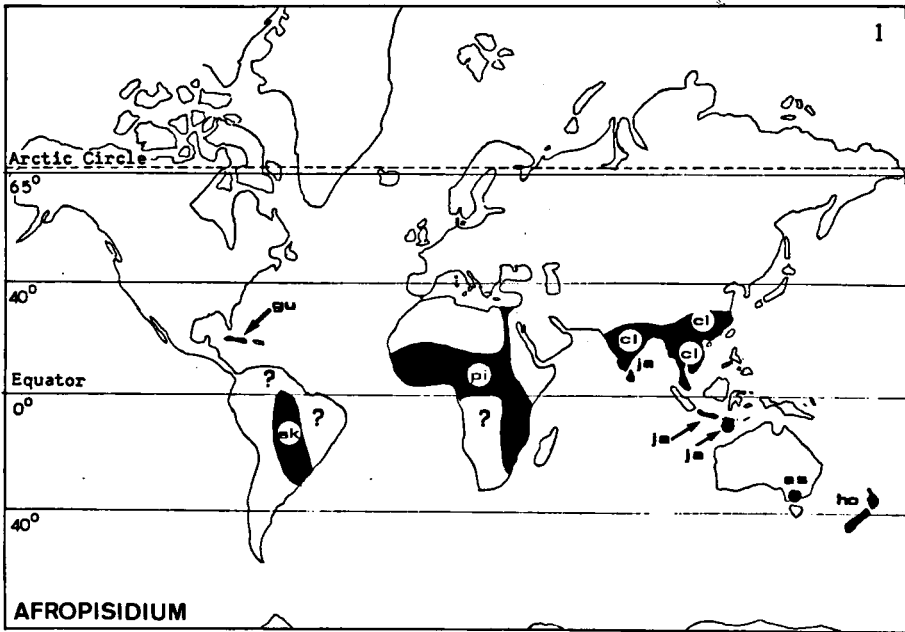
Odhner (1921, 1929, 1940) was the first to bring serious anatomical arguments into the discussion on the subgeneric division of *Pisidium*. Odhner demonstrated that the nephridia, the gills and the siphonal apertures have characteristics of taxonomic value. He distinguished on anatomical grounds three groups in Scandinavian material viz., *Pisidium* s.s., *Eopisidium* and *Neopisidium*, which he considered subgenera. Unfortunately Odhner did not always respect the rules of zoological nomenclature, which has caused some confusion as to the interpretation of these names. For further discussion I may refer to Boettger (1961) and Bowden & Heppell (1968). Objections against Odhner's anatomical norms in the subgeneric taxonomy in *Pisidium*, partially already recognized by Odhner himself (1938: 237), are summarized by Kuiper (1966a): (1) the shells of the species belonging to *Neopisidium* are too diverse to be taken as closely allied, (2) the norm of the number of gills separates sometimes forms of conchologically the same species, (3) intermediate forms combining a single gill on each side with two siphonal apertures and even complete absence of such apertures (viz., *P. conventus* Cl., personal communication Dr. W. Hinz, Duisburg) have been observed, (4) *Neopisidium* and *Eopisidium*, as originally proposed by Odhner, have no clear biogeographical identity, both being cosmopolitan.

Kuiper (1962) separated two groups from *Neopisidium*, viz., *Afropisidium* and *Odhneripisidium*, the former with a protruding ligament and an extraverted ligament-pit, the latter with introverted ligament and ligament-pit.

The subgenus *Afropisidium* has an Eogaeon (Meek, 1916: 398) distribution (fig. 1). In South America East of the Andes (Paraguay, Uruguay, Brazil) it is represented by *P. sterkianum* Pilsbry, *P. gundlachi* Arango⁵ and *P. consanguineum* Prime⁶, both from Cuba, are identical with *P. sterkianum* and therefore senior synonyms. For reasons of nomenclatorial stability I postpone any priority conclusions until the other published central and South American species of *Pisidium* are better known in this respect. In Africa, *Afropisidium* is mainly represented by *P. pirothi* Jickeli (Kuiper, 1968), and in Asia, South of the Himalayas, by *P. clarkeanum* Nevill, which has been recorded as far East as the Chinese province Szechuan (USNM 349157) and the New Territories of Hong Kong (leg. B.S. Morton 1982, ZMA/K 23060). *P. javanum* Benthem Jutting is widely distributed in S.E. Asia (Benthem Jutting, 1955; Kuiper, 1965; 1979; Brandt, 1974). In New Zealand *P. hodgkini* Suter (Kuiper, 1966b) represents the subgenus. In Australia is *P. aslini* n. sp. Some other species of *Afropisidium* have been published, each known only

⁵Lectotype (L 4.9, H 3.8, D 2.5 mm) MCZ 19851 selected in 1973 by Dr. C. Meier-Brook, without publication.

⁶Lectotype (L 4.3, D 3.6, D 2 x 1.33 mm) MCZ 19938 selected in 1973 by Dr. C. Meier-Brook, without publication.



from a limited area. The most remarkable among them is the very polymorphic *P. giraudi* Bourguignat, the only species of *Pisidium* occurring in the geologically old Lake Tanganyika in tropical Africa. The oldest known fossil record of *Afropisidium* is *P. lepersonnei* Gautier & Van Damme (1973) from Miocene deposits in central Africa. All species of *Afropisidium* mentioned have not only striking conchological similarities which justify their classification in the same taxon, but are specifically well defined, even in the rare cases of association. The latter is illustrated by *P. clarkeanum* and *P. javanum* which often occur associated in the Indian subcontinent (Brandt, 1974), and then may be separated without difficulty. In contrast to the Northern Hemisphere, where several species of *Pisidium* have a wide distribution in Nearctic as well as in Palaearctic, each species of *Afropisidium* only occurs in one of the four continental parts of Eogaea.

The question arises whether *Afropisidium* is a "Gondwanaland faunistic relic" (Bruggen, 1980). The fact that it also occurs on Caribbean and on Indonesian islands, which both are geologically younger than Gondwanaland, is in this connection, to my mind, not important, in view of the fact that these small clams have means of passive long distance dispersal. Only oceans and climatic belts seem to be absolute dispersal barriers for afropisidia. Having regard to the fact that *Pisidium* is an old and conservative group in which speciation is very slow, a "Gondwanic" (Parodiz, 1982) origin of *Afropisidium* is, in my opinion, not impossible.

The subgenus *Odhneripisidium* has an Eurasian distribution (fig. 2). Its southernmost records are on the island of Sumba, Indonesia (*P. dammermani* Odhner, 1940), some 700 km from the northern Australian coast, and on the Bismarck Archipelago (*P. novobritanniae* Kuiper, 1967), about 900 km NE of the Australian continent. *Odhneripisidium* is not known from Australia, but a not yet identified species (ZMA/K 20462, 2 right valves) of this subgenus has been collected by Dr. B. Verdcourt on 9.III.1976, in a small stream in the Lae Botanical Gardens, Morobe district, Papua New Guinea. The discovery of *Odhneripisidium* in tropical Australia is therefore likely.

Compared to the geographical nearest species of *Sphaerium* viz., *S. ranae* Benthem Jutting, from Irian Jaya (West New Guinea) (Odhner, 1940), the Australian *S. tasmanicum* and *S. lacusedes* on the one hand and the New Zealand *S. novaezealandiae* on the other seem to be closely allied. Both could be classified in the subgenus *Sphaerinova* Iredale, 1943, of which the type-species is *S. macgillivrayi* Smith.

Smith (1883) drew attention to the resemblance of a series of *Sphaerium* from the Sydney Botanical Gardens to *S. (Musculium) lacustre* (Müller) from England, and Petterd (1889: 63) suggested *S. tasmanicum* may prove to be an acclimatized form of "a British species". Heard (1977: 448) treated both *S. tasmanicum* and *S. novaezealandiae* as species of *Musculium*. The specimens from the Sydney Botanical Garden which I have had the opportunity to examine belong, in my opinion, all to *S. tasmanicum* (AMS C.109876 and C.37325), but I do not exclude the possibility that *M. lacustre*, when introduced, will acclimatize in Australia.

Fig. 1. Distribution of the subgenus *Afropisidium*: as = *aslini*, cl = *clarkeanum*, gu = *gundlachi*, ho = *hodgkini*, ja = *javanum*, pi = *pirothi*, sk = *sterkianum*.

Fig. 2. Distribution of the subgenus *Odhneripisidium*: an = *annandalei*, da = *dancei*, dm = *dammermani*, no = *novobritanniae*, pa = *parvum*, sm = *sumatranum*, sp = not yet identified species, st = *stewarti*, te = *tenuilineatum*. Four fossil (Quaternary) species in NE. Siberia, N. of the Arctic Circle (Starobogatov & Streletzkaia, 1967).

In this connection I may note that *Sphaerinova* has an externally visible, protruding ligament, which is not the case with *Musculium* and that none of the Australian species have the particular bean-shaped embryonic shell characteristic to *M. lacustre*.

7. COLLECTING AND PRESERVATION

I will give only a brief account of the methods of collecting sphaeriids, as it is covered reasonably well in most limnological handbooks and malacological identification works. Burch (1975) describes and illustrates some instruments.

In shallow water I personally prefer the use of a simple hemispheric metallic kitchen sieve, somewhat adapted and fixed onto a wooden stick of 2 m length. The mesh should not exceed 0.8 mm in diameter in order to be sure that small species as well as juveniles will be collected. By shaking this instrument, filled with bottom mud, in water, the fine sand and mud pass through the mesh. Plant remains and organic particles lighter than molluscs are removed by carefully submerging the sieve and moving it sideways. Finally, a residue of small organisms remains. Picking out the sphaeriids in the field takes too much time. It is preferable to collect as much debris as possible and to put this into a vessel in 70% alcohol. After a couple of days the residue is spread out on newsprint over a 24 hour period. Once dried, sorting out the sphaeriids is then an easy job. It is advisable to keep the specimens selected for complete drying in open boxes for several weeks before putting them into glass tubes.

In depths of more than 1 meter a special dredge is required (see Burch, 1976). In order to be sure that all associated species will be collected, at least 100 specimens from each biotope are desired.

For purposes of identification, faunistic listing and quantitative analysis in the framework of ecological research, dried specimens are preferable. Preservation in liquid generally does not facilitate identification of large series. At the present level of our anatomical knowledge, examination of the soft parts rarely brings a solution in cases of doubt. Examination of the shape of embryonic shells is one of the means of identification control, but this can also be done by opening dried specimens.

Formalin as a preservative liquid has the disadvantage that it often corrodes the shell and gives an unnatural lustre to the periostracum. As a matter of fact the lustre of the fresh shell is a relatively important diagnostic character in this group, although more in the Northern than in the Southern Hemisphere. Dr. Ponder notes (personal communication) that, in his experience, corrosion does not occur unless vegetable material was included in the field sample. He points out that acids (tannic acid) leach out of the wood, sticks, leaves, etc. and deneutralize the buffered formalin and that, if formalin is used (only ca. 7% neutral formalin), care should be taken that no vegetable matter is in the sample.

Boiling the shell in caustic soda in order to have a clean hinge, a formerly used method, leads inevitably to destruction of the shell. Boiling in water only is generally sufficient to eliminate dried soft parts from the hinge.

8. IDENTIFICATION AND TERMINOLOGY

figs. 3-11

As already said in the introduction, the utility of identification keys for sphaeriids is, to my mind, doubtful. For that reason I have not tried to construct one for Australia. The best way to identify sphaeriids is comparing specimens not only with text and figures, but above all with well identified specimens in public collections. Some training to recognize, distinguish and memorize the various forms is needed.

For the identification of pisidia a binocular microscope with at least 30x magnification is required. Shells should be examined dry. Sculpture and lustre are hardly perceivable on shells in liquid.

In the practice of sphaeriid identification work, the shell is currently more important than the soft parts. Shells without soft parts are identifiable, but identification of animals without shell is impossible at present. Nevertheless, soft parts may sometimes be helpful in cases of conchological doubt e.g., the shape of fry in brood pouches. The variability of the shell of many sphaeriid species is well known, but hardly anything is known of the variability of soft parts. On the actual level of our experience the anatomy of sphaeriids mainly contributes to subgeneric and generic classification.

Important characters are the shape of the shell, its relative convexity (fig. 8), the shape and position of its beaks, the sculpture and lustre of the periostracum. As to the hinge, attention should be given to the position (figs. 9, 10) and the shape of the ligament and the ligament-pit, the shape of the cardinal teeth, the development of the lateral teeth, the relative length of the hinge (distance cusps A2-P2) compared to the shell length (fig. 7).

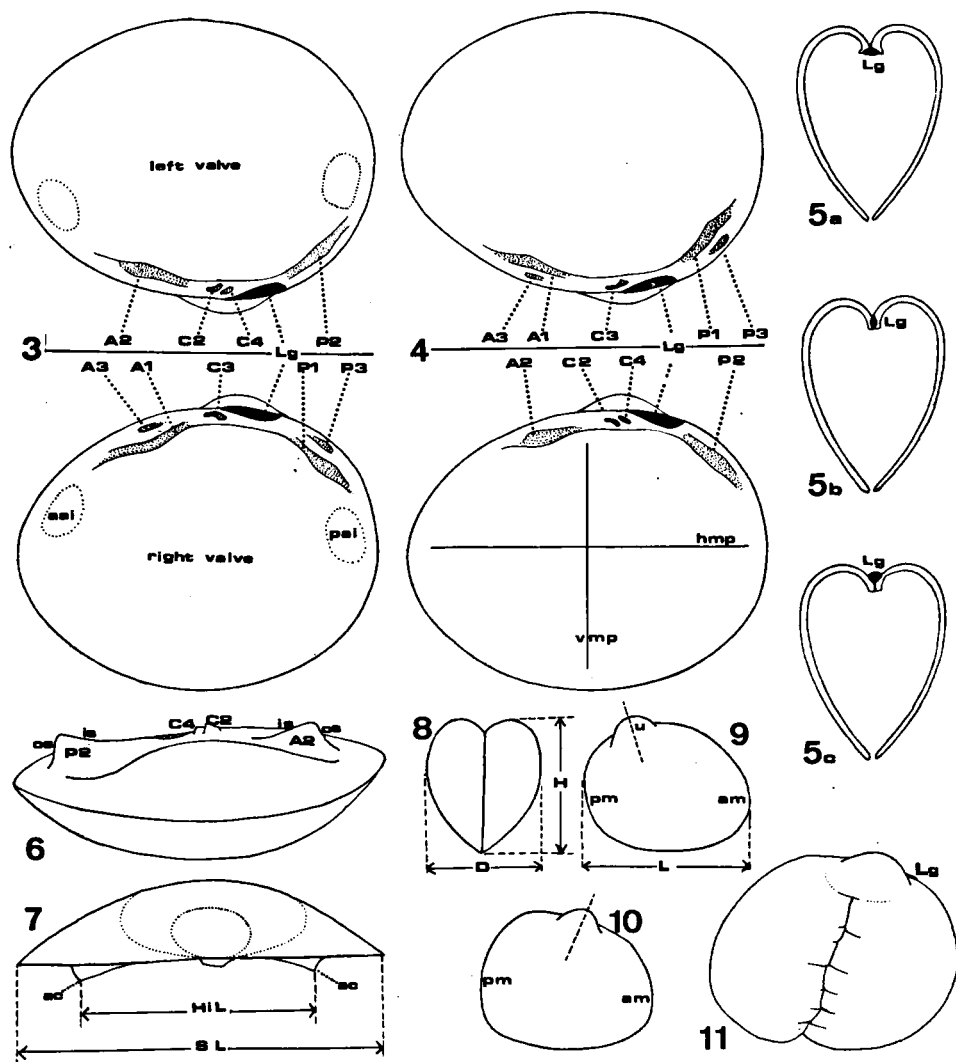
Attributing primary identification value to the hinge is, in my opinion, contradicted in practice. To a trained eye 90% of the shells are identifiable without looking at the hinge, but the opposite is a much more difficult task.

Technical terms used in the following descriptions are explained in figs. 3 to 11.

The normal dentition (fig. 3) of sphaeriids is: right valve, two anterior lateral teeth (A1 and A3), one cardinal tooth (C3) and two posterior lateral teeth (P1 and P3); left valve, one anterior lateral tooth (A2), two cardinal teeth (C2 and C4) and one posterior lateral tooth (P2). Exceptionally, reversal of dentition occurs. In total reversal (fig. 4), which is rather rare, the elements of the right valve appear in the left valve, and vice versa. In partial reversal, one or two groups of teeth only are reversed, the other being normally situated. The most common category of reversal in the Northern Hemisphere is that of the posterior lateral teeth only; combined reversal of anterior lateral and cardinal teeth is less common. Reversal has been recorded in a great number of Nearctic and Palaearctic species (Heard, 1969). It has rarely been observed in Australian sphaeriids. Up to now, reversal of posterior laterals only is known viz., in *S. tasmanicum* (ZMA/K 18205), *S. kendricki* (fig. 46) and *Pisidium* spec. (AMS C.43726).

Basically different from hinge-reversal is suppression of teeth in certain environmental, mostly oligotrophic, conditions. Cardinals may be reduced and the outer laterals (A3 and P3) may disappear completely. I have never seen sphaeriids without any hinge-teeth, as figured by Lubet (1976, fig. 1c). *S. lacusedes* is a case of hereditary suppression of the outer laterals in the right valve.

Shells may have one or more growth ridges or rings, also called "annuli". Such marks are often accentuated by alternation of light and dark coloured concentric zones. These



Figs. 3-11. Terminology of sphaeriid shells. - 3, Dentition: A1, A2, A3, anterior lateral teeth; C2, C3, C4, cardinal teeth; P1, P2, P3, posterior lateral teeth; Lg, ligament and ligament-pit. Adductors: aai, anterior adductor impression; pai, posterior adductor impression. - 4, Reversed dentition. Median plans: vmp, vertical median plan; hmp, horizontal median plan. - 5, Situation of ligament (Lg) and ligament-pit: 5a, introverted; 5b, enclosed; 5c, extraverted ligament-pit and protruding ligament. - 6, Ventral view on hinge, left valve: is, inner or proximal slope of laterals; os, outer or distal slope of laterals. - 7, Measuring of ratio hinge-length (HiL) and shell-length (SL); ac, apex or cusp. - 8, Height index (H.i.) = $100.H:L$. Convexity index (C.i.) of single valve: $100.D:2H$. Descriptive terms of convexity: C.i. inferior to 30 = shell flat or compressed; C.i. between 30 and 40 = moderately or slightly convex, tumid, swollen; C.i. between 40 and 50 = inflated, globose, globular or ventricose; C.i. more than 50 = very or extremely tumid, inflated or ventricose. - 9, Beak or umbo (u) inclined backward (opisthogyrous); am, anterior or front margin of the shell; pm, posterior margin. - 10, Beak inclined forward (prosgogyrous). - 11, Diphyoid shell.

phenomena have no identification value. In opposition to Favre (1927: 303, "arrêts de croissance annuels") and Heard (1965: 386, "the number of annuli reflects the age of the individual animal"), Meier-Brook (1970: 114) argues on good grounds the unreliability of such marks and zones as age indicators, and states that "a reliable method of age determination is still wanting". Heard (1977) concluded finally that the "number of annuli of the shell may be an index of general age, but are considered to be unreliable in assessing life spans".

The presence of a marked nepionic or embryonic cap (figs. 13, 14, 20, 27, 29) is not a reliable diagnostic character in either *Sphaerium* or *Pisidium*. Both forms with and without such a cap often occur in the same population. Gale (1972) demonstrated experimentally with *S. transversum* (Say) that the proportion of "calyculate and non-calyculate" forms is liable to seasonal fluctuations.

Another conchological feature without taxonomic value is the so-called diphyoidy. A diphyoid shell (fig. 11) shows a more or less developed transverse furrow ("scar" in American literature) in the mesial part of each valve (Chaix, 1973). Bourguignat (1852: 49), in his *P. sinuatum*, took this phenomenon erroneously to be a character of specific value (Favre, 1943: 38). As to its cause, Sterki (1906) supposed it may be "a parasite affecting the mantle edges in some way and thus causing the deformity of the shell". The shell of *S. tasmanicum* in fig. 26 shows a light degree of diphyoidy.

9. SYSTEMATICS

9.01 *Sphaerium tasmanicum* (Tenison Woods)

figs. 14-29, 41, 42, 100

- 1876 *Cyclas tasmanica* Tenison Woods, p. 82.
- 1876 *Pisidium dulvertonensis* Tenison Woods, p. 82.
- 1876 *Sphaerium translucidum* Sowerby, - Reeve, pl. 5, f. 46.
- 1879 *Calyculina tasmanica*, - Clessin, p. 261, pl. 41, f. 1, 2.
- 1879 *Pisidium Dulvertonensis*, - Petterd, p. 87.
- 1882 *Sphaerium Tasmanicum*, - Tate & Brazier, p. 565.
- 1882 *Pisidium Dulvertonensis*, - Tate & Brazier, p. 565.
- 1883 *Sphaerium translucidum*, - Smith, p. 305.
- 1883 *Sphaerium queenslandicum* Smith, p. 305, pl. 7, f. 33.
- 1883 *Sphaerium Macgillivrayi* Smith, p. 305, pl. 7, f. 34.
- 1887 *Sphaerium Macgillivrayi*, - Tate, p. 94.
- 1889 *Cyclas tasmanica*, - Johnston, p. 87.
- 1893 *Sphaerium Macgillivrayi*, - Adcock, p. 12.
- 1914 *Sphaerium tasmanicum*, - Chapman, p. 56.
- 1921 *Sphaerium macgillivrayi*, - May, p. 68.
- 1921 *Sphaerium tasmanicum*, - May, p. 68.
- 1921 *Pisidium dulvertonensis*, - May, p. 68.
- 1921 *Sphaerium dulvertonensis*, - May, p. 21, pl. 9, f. 7.
- 1921 *Sphaerium tasmanicum*, - May, p. 21, pl. 9, f. 9.
- 1921 *Sphaerium macgillivrayi*, - May, p. 21, pl. 9, f. 8.
- 1923 *Sphaerium macgillivrayi*, - May, pl. 9, f. 8.
- 1923 *Sphaerium tasmanicum*, - May, pl. 9, f. 9.
- 1936 *Sphaerium macgillivrayi*, - Cotton, pl. 85, f. 48.
- 1938 *Sphaerium tatiarae* Cotton & Godfrey, p. 178, f. 181.
- 1939 *Sphaerium tasmanicum*, - Gabriel, p. 127, pl. 4, f. 35.

- 1943 *Sphaerinova macgillivrayi*, - Iredale, p. 195.
 1943 *Sphaerinova victoriana* Iredale, p. 195.
 1943 *Sphaerinova tatiarae*, - Iredale, p. 195.
 1943 *Sphaerinova nundinalis* Iredale, p. 195.
 1943 *Sphaerinova tasmanica*, - Iredale, p. 195.
 1943 *Sphaerinova queenslandica*, - Iredale, p. 196.
 1943 *Sphaerinova translucida*, - Iredale, p. 196.
 1943 *Australpera* (?) *dulvertonensis*, - Iredale, p. 196.
 1943 *Australpera bradena* Iredale, p. 196.
 1943 *Sphaerinova nundinalis*, - Iredale, p. 95, f. 3.
 1953 *Sphaerinova bursa* Cotton, p. 21.
 1955 *Sphaerinova tasmanica*, - Kershaw, p. 296.
 1955 *Australpera dulvertonensis*, - Kershaw, p. 296.
 1958 *Australpera dulvertonensis*, - May & Hope MacPherson, p. 26, pl. 9, f. 7.
 1958 *Sphaerinova tasmanica*, - May & Hope MacPherson, p. 27, pl. 9, f. 9.
 1961 *Sphaerinova tatiarae*, - Cotton, p. 188, f. 187 (left).
 1961 *Sphaerinova bursa*, - Cotton, p. 189, f. 188 (left).
 1977 *Musculium tasmanicum*, - Heard, p. 448.
 1979 *Sphaerium* (*Musculium*) *tasmanicum*, - Smith & Kershaw, p. and f. 255.

Description. - Outline of shell subquadrangular (figs. 23-25), beaks prominent, sometimes with a well marked embryonic or nepionic cap, median and slightly prosogyrous. Posterior margin subtruncate, anterior narrower, attenuate. Upper margin less rounded than lower margin. Shell, thin, fragile, subtransparent, greyish, often with one or more growth ridges and darker concentric zones. Sculpture very fine, irregular concentric lines (20-24 per $\frac{1}{2}$ mm), dull shining, beaks nearly smooth. Ligament visible exteriorly, protruding in full-grown specimens. Ligament-pit very narrow and relatively long, about $\frac{1}{5}$ of the shell-length, at its inside bordered by a ridge. Hinge extremely narrow in its central part. Cardinal teeth of left valve very small, straight, short, C2 above and behind C4; cardinal tooth of right valve, C3, twice as long as left cardinals, thickened at its posterior end. Lateral teeth of left valve, A2 and P2, as well as those of right valve, A1, A3, P1 and P3, very narrow with long inner slopes.

Dimensions. - Tenison Woods (1876) gives the following measurements: L 9, H 7.5, Diam. 5 mm, calling it "a somewhat small *Cyclas*". As a matter of fact I have rarely seen such large Australian sphaeriids. In a series collected by T.W.H. Clarks in the Elizabeth River, Tasmania (TMH E.3071), I found the following dimensions in mm:

| L | H | D | C.i. | H.i. |
|------|------|------|------|------|
| 8.25 | 6.40 | 4.25 | 33 | 78 |
| 7.95 | 6.55 | 4.30 | 33 | 82 |
| 6.80 | 5.50 | 3.55 | 32 | 81 |
| 5.90 | 4.80 | 3.00 | 31 | 81 |
| 4.55 | 3.80 | 2.20 | 28 | 84 |

In a series from Mt. Duaringa, Lagoon at Coomooboolaroo, Queensland (AMS C.109829) I found the following dimensions in mm:

| | | | | |
|------|------|------|----|----|
| 8.40 | 6.90 | 4.50 | 33 | 82 |
| 6.40 | 5.30 | 3.00 | 28 | 83 |
| 5.00 | 4.00 | 2.30 | 28 | 80 |
| 4.20 | 3.50 | 1.80 | 25 | 83 |
| 3.40 | 2.90 | 1.70 | 28 | 85 |
| 2.80 | 2.30 | 1.20 | 26 | 82 |
| 2.40 | 2.00 | 0.90 | 23 | 83 |

The convexity index increases somewhat during growth.

Variability. – *S. tasmanicum* shows variation in the outline of its shell, the convexity of the shell, the shape of the beaks and especially the hinge. Small differences between topographically separated populations has led to the creation of distinct species. Mostly it concerns local forms (not subspecies) or even individual modifications. As already has been pointed out in section 8, a marked embryonic cap is not a reliable diagnostic character.

I have not seen Tenison Woods' type-specimens from the neighbourhood of Swansea, Tasmania, but some fragments of shells (measuring at most 8 mm in length) in the Tenison Woods' Collection (TMH E.111/7452), without any indication of origin, are possibly the type-lot. A series from the Elizabeth River, Tasmania (TMH E 3071) fit, in my opinion, the original description.

Forms:

- *terenda* Iredale (fig. 28) is a small, thin, roundish form without umbonal cap; the holotype (AMS C.110522) measures L 5.5, H 4.7, D 2.8 mm.
- *bradena* Iredale (fig. 22) has a relatively short upper margin and a short hinge; the holotype (AMS C. 100521) is a single right valve measuring L 8.5, H 6.8, D 2.8 mm; the length of its ligament-pit is only $\frac{1}{7}$ of that of the shell-length.
- *nundinalis* Iredale (fig. 18) is characterized by its elongated, anteriorly somewhat pointed shape; the lectotype (AMS C.109823), herewith designated, measures L 7.3, H 5.6, D 3.5 mm.
- *tatiarae* Cotton & Godfrey (fig. 41) is subcircular; the holotype (SAM D.12583) measures L 8.2, H 7.3, D 4.8 mm.
- *bursa* Cotton (fig. 42) is scarcely different from the latter, being somewhat more oval; the holotype (SAM D.14453) measures L 8.5, H 7.8, D 4.8 mm.

Distribution (fig. 100) and habitat. – *S. tasmanicum* is common in Tasmania, South Australia, Victoria, New South Wales and Queensland (southern part). It lives in rivers, creeks, *Sphagnum* pools, bogs, waterholes, swampy springs, artificial ponds, farm dams and has also been found in a well. It has been collected up to 2500 ft. elevation at Hanging Rocks, Nundle, N.S.W. (AMS C.13736) and at a depth of 72 meters in the Blue Lake, Victoria (SAM, FWA 2456). Fossil it is known from the Pleistocene marl of Mowbray swamp, NW. Tasmania, about 12 miles W. of Smithton (Chapman, 1914). *S. tasmanicum* is often accompanied by *P. tasmanicum*.

Samples in public collections.

Queensland. – Lagoon at Coomoooolaroo, Mt. Duaringa, Dawson district (AMS C. 109829 s.n. *S. translucidum*); Port Curtis (AMS C.264); Pittsworthy, Darling Downs, from the bottom of a well, through basalt, about 10 ft. deep, leg. Nei. (AMS C.54570, ZMA/K 15008); Lilysmere Lagoon, Burdekin (AMS C.63909); Eidsvold, leg. Ban. (AMS C.33767); Holland Park, Brisbane (AMS C.63913, ZMA/K 15004); Bulimba Ck., leg. Art. c.s. 1979 (Griffith Univ., Nathan); O'Reilly's Lamington National Park, in artificial pond, 28°27'S, 153°12'E, leg. Pon. 1981 (AMS 128697).

New South Wales. – Braidwood (AMS C.100521, holotype of *Australpera bradena*); Shoalhaven R., Braidwood, in a pond, leg. Bra. (AMS C.109817); Nundle (AMS C.109823, lectotype of *Sphaerinova nundinalis*); Hanging Rock, Nundle, 2500 ft. (AMS C.13736, C.109877, ZMA/K 22071); Sydney, Botanic Garden (AMS C.13735, 109876, ex Musson Coll. s.n. *S. lacustre*); Sydney, Parramatta R. (AMS C.63918); pond at Dobroyd, Sydney (AMS C.350); Campbelltown nr. Sydney, leg. Kng. (AMS C.13739); pond nr. Randwick Rd, Sydney, 1885 (AMS C.63916); Turramurra, Sydney, leg. Gru. (AMS C.42268); Murrumbidgee R., leg. Cle. (AMS C.13734); Leeton, Murrumbidgee R. (AMS C.100522, holotype of *Sphaerinova terenda*; AMS C.109821, paratype); Wyong Ck., Wyong, leg. Cox (AMS 109875); Wyong Ck. (AMS C.63915, ZMA/K 15007); Port Stephens, leg. Kin. (AMS C.13737); Cox's R. nr. Katoomba nr. Grand Faults, leg. Gra. 1933 (AMS C.63899); Black Dog Ck. below junction of Koromung and Cox's R. (AMS C.109815); nr. Camden (AMS C.109816); Walcha (AMS C.109814);

Peel R., Tamworth (AMS C.109879, ex Musson Coll.); Brogo R. nr. Bega, leg. Col. 1953 (AMS 63903, ZMA/K 15011); Trangie, leg. Shi. (AMS C.28332); Cobas, leg. Abr. (AMS C.30984); Ash Is., N. of Newcastle (AMS C.109812); Seven Mile Ck. W. of Bolivia, New England district, 29°18'S, 152°04'E, leg. Pon. 1981 (AMS C.128926); Hoffman's Ck. with trib., Hervetson's Hill, E. of Legume, 28°26'S, 152°24'E, leg. Pon. 1981 (AMS C.128686); trib. of Peacock Ck. on road to Kyogle, 11 km NNE. of Urbenville Rd. turnoff, 28°41'S, 152°42'E, leg. Pon. 1981 (AMS C.128717); Ford on Byrrill Ck. Rd. at Pretty Gully, 28°27'S, 152°14'E (AMS C.128722); trib. of Byrrill Ck., Mebbin State Forest, 28°27'S, 153°14'E, leg. Pon. 1981 (AMS C.128696); Lake Liddell, W. end, 32°23'S, 151°00'E, leg. Mcw. Hoe. & Pax. 1972 (AMS C.129137); King's Ck., trib. of McIntyre R., leg. Hal. (AMS C.109825); Tuross R. valley nr. E. end Cadger Rd., 36°09'S, 149°55'E, leg. Pon. 1981 (AMS C.128099); small, swampy trib. of Big Badja R., 2 km N. of Badja on Gundillion Rd., 36°03'S, 149°32'E, leg. Pon. 1981 (AMS C.128105); 1.7 km W. of Adaminaby on Snowy Mts. Rd., 36°00'S, 148°42'E, swampy pool, leg. Pon., Hal. 1980 (AMS C.126965).

Victoria. - Yan Yen Reservoir, Plenty district (BML, one specimen in the type-lot of *P. etheridgei*); Carrum Ck. nr. Melbourne (AMS C.298); stream on Wellington Rd. nr. Rowville, E. of Melbourne, 37°56'S, 145°14'E, leg. Pon. 1969 (AMS C.129133); Meredith, leg. Gab. (AMS C.43726); Mt. Eccles, leg. Wha. (AMS C.5367); Mt. Eliza, leg. Pri. (AMS C.649); ornamental lake Botanic Gardens Castle-maine (AMS C.1718); Rickett's Point, Fort Phillip, leg. Ker. (AMS C.109826); Mississippi Ck., Colquhoun Rd., leg. Pla. (NMV); irrigation drain, State Res. Farm at Werribee (NMV); Macalister R., W.S. Survey-Primrose Gap N. side, 1972 (NMV); 1 mile S. of Beaufort, Avoca and Lexton crossroads, in farm dam, leg. Smi. & Pla. 1972 (NMV); pond at junction of Tanjil Bryne-Baw Baw Erica roads, leg. Smi. 1969 (NMV); nr. Rowville, E. of Melbourne, 37°36'S, 145°14'E, stream on Wellington Rd. (AMS C.129133); 50 km S. of Murrayville between "Big Billy Bose" and "Moonlight tank", 1974, Grid ref. 436595 (NMV).

South Australia. - Valley Lake, Mt. Gambier, ex Hel. ex Adc. (AMS C.39180); Lake Bonney, at Cory's Landing, leg. Asl. 1975 (SAM FWA 2671); Blue Lake nr. Mt. Gambier, leg. Tuc. (SAM FWA 2446); ibidem, leg. Har. 1974 (SAM FWA 2456); Woolwash Cave "Barnoolut" SE. of Mt. Gambier, leg. Asl. 1972 (SAM FWA 1573, ZMA/K 23033); Penola, leg. Asl. 1975 (SAM FWA 1348); Penola Station garden, leg. Asl. 1971 (SAM FWA 1070); creek flowing into Lake George, N. of Beachport, leg. Loc. & Han. 1978 (AMS C.128212).

Tasmania. - Lake Hugill (probably one of the Hugel Lakes), leg. Wig. 1960 (TMH E.3229); Lake Dulverton, ex Tenison Woods Coll. (TMH E.1452); Lake Dulverton, leg. Mol. 1961 (TMH E.10982; ZMA/K 23035); Lake Tiberias, leg. Mol. 1960 (TMH E.10975); Lake Crescent at Clyde R., leg. Mol. 1963 (TMH E.10990); Arthur's Lake, morass, leg. Mol. 1960 (TMH E.10981); Southern Cleveland Lagoon, leg. Mol. 1964 (TMH E.10991); Redlands Lagoon, Plenty River System, leg. Mol. 1965 (TMH E.10986); Rebecca Lagoon, leg. Mol. 1963 (TMH E.10979; ZMA/K 23036); Lagoon of Islands, leg. Mol. 1965 (TMH E.10977; ZMA/K 23040); Maria Is., ex Pet. (AMS 27755); Knocklofty, W. Hobart, pond, leg. Dar. 1969 (TMH); Hobart, ex. Pet. (AMS C.27754); Redlands drain, Plenty R., leg. Mol. 1965 (TMH E.10987); York Plains, leg. Joh. (TMH E.3080, ZMA/K 18205); Elizabeth R., leg. Cla. (TMH E.3071); Rosetta, pond off Mary's Hope Rd., Glenorchy, leg. Gre. 1964 (TMH E.3624); St. Leonards (TMH E.5193, 2710); Coal R., Campania, leg. Slo. 1977 (IFC, ZMA/K 21010); Sandfort (AMS 63902); South Esk R., ex Pet. (AMS 27756); Ouse R. (AMS E.63906, 63912); Barnards Ck. (TMH E.3101).

9.02 *Sphaerium lacusedes* (Iredale)

figs. 30-40, 98

1923 *Sphaerinova macgillivrayi*, - May, pl. 9, f. 8.

1943 *Sphaerinova lacusedes* Iredale, p. 195.

1955 *Sphaerinova lacusedes*, - Kershaw, p. 296.

1958 *Sphaerinova lacusedes*, - May & Hope MacPherson, pl. 9, f. 8.

Description. - Shell nearly circular, thin but not transparent, densely porous (more than 400 pores per square mm). Dorsal, posterior, ventral and anterior margins constitute a regular curve, with the exception of the segment between the cardinals and the antero-superior (faint) edge, which is nearly straight. The mean H.i. of adult specimens is 42.

Flat shells are more oval. The mean C.i. of adult specimens is about 28. Beaks median, prosogyrous, low, nearly absent in young and half-grown individuals. Colour: yellow-horn with a dull gloss. Sculpture: concentric, fine ribs, becoming coarser and more regular towards and on the beaks (9 per $\frac{1}{2}$ mm). Ligament in adult individuals not or hardly visible exteriorly, and not protruding. Ligament-pit narrow, pointed at both extremities. Hinge very thin, extremely narrow, especially in the central part. Cardinal teeth: C2 and C4 minute, straight, C4 behind and above C2; C3 short, a little curved, clavate. Lateral teeth: outer laterals A3 and P3 absent, inner laterals very thin, short.

Dimensions in mm of specimens taken at different dates in the Southern sector of the East Lake, which is a part of the Arthur's Lake.

| L | H | D | C.i. | H.i. | L | H | D | C.i. | H.i. |
|------|------|------|------|------|------|------|------|------|------|
| 9.55 | 8.20 | 4.60 | 28 | 86 | 5.00 | 4.30 | 2.40 | 28 | 86 |
| 8.80 | 7.65 | 4.40 | 28 | 87 | 4.90 | 4.10 | 2.30 | 28 | 84 |
| 8.60 | 7.50 | 4.30 | 28 | 87 | 4.80 | 4.00 | 2.10 | 26 | 83 |
| 8.45 | 7.25 | 4.40 | 30 | 86 | 3.90 | 3.20 | 1.80 | 28 | 82 |
| 7.70 | 6.50 | 3.75 | 28 | 84 | 3.75 | 3.10 | 1.90 | 30 | 83 |
| 7.50 | 6.25 | 3.65 | 29 | 83 | 3.40 | 2.70 | 1.40 | 25 | 79 |
| 7.25 | 6.15 | 3.50 | 28 | 85 | 3.00 | 2.35 | 1.10 | 23 | 78 |
| 6.60 | 5.60 | 3.10 | 28 | 85 | 2.90 | 2.25 | 1.00 | 22 | 78 |
| 6.10 | 5.10 | 2.85 | 28 | 84 | 2.40 | 1.90 | 0.90 | 24 | 79 |
| 5.85 | 4.95 | 2.75 | 28 | 85 | 2.30 | 1.80 | 0.80 | 22 | 78 |

Distribution (fig. 98). - Only known from Tasmania, the Great Lake and the Arthur's Lake.

Samples in public collections. - Great Lake, leg. Taf. 1902 (TMH E.5194), leg. Eva. 1939 (TMH E.2431); Cramps Bay, leg. Ful. 1975 (ZMA/K 21013); Swan Bay, leg. Eva. 1937 (TMH E.2432), ibidem at 40' depth, leg. Ful. (ZMA/K 21016). - Arthur's Lake: several series from East Lake, collected by W. Fulton from 1975 to 1978. Specimens lodged in the collections of: AMS, TMH, ZMA/K, BML and IFCH.

Remarks. - Iredale's publication of *Sphaerinova lacusedes* is too short. Without any description of the shell, he only refers to May's figure of *Sphaerinova macgillivrayi* which, in Iredale's opinion, was a misidentification. Nevertheless, Iredale's name is valid according to the rules of zoological nomenclature (1961, art. 16.a.i.) My own interpretation of *S. lacusedes* is supported by the fact that the type locality, the Great Lake in Tasmania, seems mainly to be inhabited by just one species of *Sphaerium*, which is not the common, widely distributed *S. tasmanicum*.

I have not seen Iredale's type-specimens of *S. lacusedes*. The following description is based on material I had the opportunity to examine through the courtesy of Dr. Wayne Fulton, biologist of the Inland Fisheries Commission at Hobart, who has dredged between 1975 and 1978 at many points in the Great Lake as well in the nearby Arthur's Lake.

S. lacusedes differs from *S. tasmanicum*, which also lives in the Arthur's Lake (Cow-paddock Bay), by (1) the outline of the shell, (2) the low beaks, (3) the finely ribbed sculpture around the beaks, (4) the yellowish periostracum, (5) the absence of outer laterals (A3 and P3). The C.i. varies between 22 and 30, the H.i. between 78 and 87. These values increase during the growth.

9.03 *Sphaerium egregium* (Gould)

fig. 96

- 1846 *Cyclas egregia* Gould, p. 86.
 1851 *Cyclas egregia*, - Gould, p. 292.
 1852 *Cyclas egregia*, - Gould, p. 425, f. 526, 526a, 526b
 1854 *Sphaerium egregium*, - Deshayes, p. 273.
 1856 *Cyclas egregia*, - Gould, pl. 36, f. 526.
 1882 *Sphaerium egregium*, - Tate & Brazier, p. 565.
 1883 *Sphaerium egregium*, - Smith, p. 305.
 1939 *Sphaerium egregium*, - Gabriel, p. 272.
 1961 *Cyclas egregia*, - Johnson, p. 71.

Gould (1851) describes the species as follows:

"T. ventricosa, transversa, oblonga, sub-equilateralis, concentric tenui-lirata; umbonibus parum elevatis tumidis; epidermide viride-corneo, fusco-zonato, plerumque *C. cornea* similis. Long 7/8; alt. 6/8; lat. 1/2 poll. Hab. New South Wales? - It is larger, more rounded in outline, and more globose in form than *C. cornea*. The epidermis is less glistening, of a deeper green, and exhibits no traces of radiations. The ligament is shorter and more prominent. The beaks, hinge, and furrowing are nearly the same in both".

Gould (1852) gives a nearly similar Latin description (there are only some small orthographic differences), but the comment gives a little more information: "The shell is so similar to *C. cornea*, that it would not be distinguished without careful examination. It is, however, larger, more rounded in outline, and more globose in form. The epidermis is less glistening, of a deeper green, and exhibits no traces of radiations. The hinge ligament is shorter and more prominent. As to its beaks, furrowing and hinge, it is almost identical. It is larger than any other species I have seen. Length seven-eighths of an inch. Inhabits Hunter's River, New South Wales".

It is the only record known up till now. Smith (1883: 305) concluded: "..... it is doubtfully Australian". I do not know whether the original material is still extant. Johnson (1961) does not mention its location. Anyhow, none of the Australian sphaeria I have examined resembles the specimen(s) figured by Gould (1856).

Smith's statement is, in my opinion, premature as long as the Hunter River has not been investigated thoroughly in this respect.

9.04 *Sphaerium problematicum* Gabriel

figs. 43, 99

- 1939 *Sphaerium problematicum* Gabriel, p. 128, pl. 4, f. 36.
 1943 *Sphaerionova problematica*, - Iredale, p. 196.

Description. - Outline oblong, ventro-dorsally compressed, subtransparent; the long upper margin and the ventral margin nearly equally curved. The shell is densely porous. Beaks pre-median, slightly prosogyrous, low. Greatest shell-length below horizontal median plan. Posterior adductor impression triangular, anterior oval, both situated above the horizontal median plan. Sculpture: very fine, silky shining, concentric lines, about 25 per 1/2 mm in the middle of the shell; around the beaks the concentric lines are traversed by a faint radial striation. Hinge-plate rather narrow, long, the distance between A1 and

D1 = 3 mm, being half the shell-length. Cardinal teeth: C2 and C4 straight, nearly parallel, but C4 behind C2; C3 long, slightly curved. Inner lateral teeth long and narrow, outer lateral teeth (A3 and P3) narrow, but well developed, much shorter than the inner lateral teeth, parallel to the latter. Ligament-pit length 1 mm, $\frac{1}{6}$ of shell-length. The ligament is probably not protruding as in *S. tasmanicum*. Measurements: The holotype has a length of 7 mm (Gabriel 1939: 128). Paratypes: L 6, H 4.2, D 3.2 mm and L 5, H 3.9, D 2.8 mm.

Distribution (fig. 99). – Only known from the Murray River near Merbein (leg. F.S. Colliver), Victoria.

Samples in public collections. – Holotype (NMV 71231), not examined by me. Paratypes: 4 lots in NMV (personal communication R. Plant, 15.V.1981); SAM D.15675; AMS C.63917.

Remarks. – *S. problematicum* is easily separated from *S. tasmanicum* and *S. kendricki* by its low shape, being less high than the two other species. Iredale (1943: 196) placed *S. problematicum* in *Sphaerinova*, but he did not explain why.

9.05 *Sphaerium kendricki* n. sp.

figs. 44-46, 97

Diagnosis. – Distinguished by its thick, opaque shell with sub-circular outline and its long, solid hinge-plate.

Description of the holotype. – Shell nearly circular, slightly convex (C.i. 31), solid, opaque. Long upper margin, less rounded than ventral margin. Beaks median, somewhat prosogyrous. Colour: dull white. Sculpture: very fine concentric striation. Hinge-plate: rather strong, relatively long, the distance between the apices of A1 and P1 being 5.4 mm (shell-length 8.2 mm). Before and behind the cardinals the hinge-plate is narrowed in both valves. Ligament not protruding. Ligament-pit short (length 1.5 mm) and narrow, pointed at both extremities. Hinge teeth: C3 (0.6 mm) curved, posteriorly bifid, C2 (0.2 mm) triangularly notched, C4 short (0.3 mm) and straight, diagonally behind C2. Lateral teeth: A1 and A3, as well as P1 and P3, long and parallel. The apices of the outer laterals A3 and P3 nearer to each other than those of the inner laterals A1 and P1; A2 and P2 with long inner slopes. Adductor impressions not distinguishable.

Dimensions. – The holotype measures: L 8.2, H 7.0, D 4.4 mm. The 28 paratypes have the following dimensions (in mm):

| | L | H | D | C.i. | H.i. | | L | H | D | C.i. | H.i. |
|-----|------|------|------|------|------|-----|------|------|------|------|------|
| 1. | 6.85 | 5.90 | 3.50 | 30 | 86 | 15. | 5.25 | 4.50 | 2.70 | 30 | 86 |
| 2. | 6.75 | 5.35 | 3.60 | 34 | 79 | 16. | 5.20 | 4.50 | 2.70 | 30 | 87 |
| 3. | 6.55 | 5.60 | 3.70 | 33 | 85 | 17. | 5.10 | 4.40 | 2.60 | 30 | 86 |
| 4. | 6.55 | 5.45 | 3.50 | 32 | 83 | 18. | 4.90 | 4.20 | 2.70 | 30 | 86 |
| 5. | 6.45 | 5.60 | 3.40 | 30 | 87 | 19. | 4.80 | 4.10 | 2.60 | 32 | 85 |
| 6. | 6.40 | 5.40 | 3.60 | 33 | 84 | 20. | 4.75 | 4.10 | 2.40 | 29 | 86 |
| 7. | 6.15 | 5.15 | 3.20 | 31 | 84 | 21. | 4.70 | 3.90 | 2.50 | 32 | 83 |
| 8. | 6.15 | 5.15 | 3.20 | 31 | 84 | 22. | 4.60 | 4.00 | 2.40 | 30 | 87 |
| 9. | 6.00 | 5.10 | 3.10 | 30 | 85 | 23. | 4.20 | 3.60 | 2.00 | 28 | 86 |
| 10. | 5.75 | 4.90 | 3.30 | 34 | 85 | 24. | 4.10 | 3.40 | 2.00 | 29 | 83 |
| 11. | 5.70 | 4.80 | 3.0 | 31 | 84 | 25. | 3.60 | 3.00 | 1.60 | 27 | 83 |
| 12. | 5.55 | 4.90 | 3.0 | 31 | 88 | 26. | 3.40 | 2.85 | 1.60 | 28 | 84 |
| 13. | 5.40 | 4.60 | 2.80 | 30 | 85 | 27. | 3.00 | 2.50 | 1.30 | 26 | 83 |
| 14. | 5.30 | 4.50 | 2.70 | 30 | 85 | 28. | 2.80 | 2.30 | 1.20 | 26 | 82 |

Type-locality. - Osborne Park, Western Australia, drain through Roselea, nursery across North Beach Road, leg. B. Muir, 2.V.1969.

Types. - Holotype (WAM 64974a). Paratypes: nos. 1, 2, 4, 5, 7-9, 11-13, 15-17, 19-24, 26-28 (WAM 64974b); nos. 3, 6, 10, 14, 18, 25 (ZMA/K 21018-21023).

Distribution (fig. 97). - Only known from Western Australia, in the following other localities. - Turner Brook, Deepdene, near Augusta, leg. Arc. c.s. 15.IX.1969, 9 left and 7 right valves, 1 juv. specimen (WAM 64774). - Lake Neerabub, North Wanneroo mud flats, W. side, leg. Arc., Jef. & Mur., 29.III.1969, 61 valves and 1 complete individual (WAM 64874). - Lake Monger, Leederville, in mud, leg. Edw. 23.XI.1958, 5 specimens (WAM 105366).

Name. - Dedicated to Mr. George Kendrick, paleontologist of the Western Australian Museum, Perth, who first drew my attention to the presence of sphaeriids in Western Australia.

Variability. - In the type series there is only a slight individual variation in outline, in relative height (H.i. 79-88) and in convexity (C.i. 26-34). The specimens smaller than 5 mm are subtransparent. In all specimens C3 is long, curved and posteriorly bifid; C2 is always short, sometimes a little hooked centrally. Whereas the adductor impressions are hardly visible in the type series, they are, on the contrary, clearly marked in the shells from Lake Neerabub, being more glossy than the rest of the shell-interior which is white and dull. The posterior impression is small, triangular; the anterior impression is oval and slightly larger than the posterior. The anterior is higher situated than the posterior one. The outline of the shells from Lake Neerabub is generally still more rounded (H.i. up to 90) than that of the type specimens. The largest shell from Lake Neerabub measures L 7.5, H 6.5, D 4.0 mm. All shells from Lake Neerabub are densely porous, especially around and on the beaks. The length of the ligament-pit is about $\frac{1}{5}$ of the shell length.

Remarks. - *S. kendricki* is easily distinguished from *S. tasmanicum* and its different local forms by having a thick shell with broad and solid hinge plate, whereas the latter is always thin-shelled and has a narrow or very narrow hinge-plate. The embryonic cap which is sometimes present in *S. tasmanicum* is absent in *S. kendricki*. *S. problematicum*, on the other hand, is smaller, oval and ventrodorsally compressed, its outline being very different from that of *S. kendricki*.

9.06 *Pisidium tasmanicum* Tenison Woods

figs. 58-64, 95

- 1876 *Pisidium tasmanicum* Tenison Woods, p. 82.
- 1879 *Pisidium tasmanicum*, - Petterd, p. 87.
- 1914 *Pisidium tasmanicum*, - Chapman, p. 56.
- 1921 *Pisidium tasmanicum*, - May, p. 68.
- 1943 *Australpera tasmanica*, - Iredale, p. 196.
- 1955 *Australpera tasmanica*, - Kershaw, p. 296.
- 1958 *Australpera tasmanica*, - May & Hope MacPherson, p. 27, pl. 9, f. 10.
- 1966 *Pisidium tasmanicum*, - Kuiper, p. 156.

Description. - The original description in Latin is followed by a translation: "Shell ovate, thin, ventricose, pellucid, whitish, regularly and concentrically striate, inequilateral or rounded on both sides; anterior side subproduced, posterior rounded obtusely, umbones

obtuse, ligament inconspicuous. Length from 2 to 4; breadth $1\frac{1}{2}$ to $2\frac{1}{2}$; height 1 to 2 mill."

Remarks. – Tenison Woods (1876: 81) gives the following localities: "Brown's River, Great Lake, Lake Dulverton, Dunrobin, and creeks near Hobarton". I have not seen authentic specimens, so that it is not possible at the moment to select a lectotype. It is possible that the sample TMH E.112, comprising about 45 shells without locality, and originating from the Tenison Woods Collection, are syntypes. In my opinion, it is justified to select a neotype from a representative sample to be collected at one of the original localities cited by Tenison Woods, under the condition that this sample is large enough to permit lodging material in several public collections.

My interpretation of Tenison Woods' description is backed by the fact that it concerns the most widely distributed Tasmanian *Pisidium*, living in rivers and creeks, as well as in lakes, ponds and ditches. Petterd (1879: 87) states as to its presence in Tasmania: "in most streams and pools". In my paper on the New Zealand sphaeriids (Kuiper, 1966: 156) I placed *P. tasmanicum* in the synonymy of *P. casertanum*, but since I obtained samples in which both forms occur, I now prefer to consider *P. tasmanicum* a distinct Australian species not living in New Zealand. When associated with *P. casertanum*, *P. tasmanicum* may be distinguished by its fine, often somewhat silky concentric striation, its relatively higher beaks, its more fragile appearance and its statistically smaller dimensions.

In the original description nothing is said on hinge-details. As a matter of fact, comparing *P. tasmanicum* with associated *P. casertanum*, the only distinguishing characters, besides the narrower hinge-plate, are the short, generally straight cardinal teeth, whereas C2 and C4 are often parallel.

Dimensions. – Specimens collected in 1976 by D. Coleman and P. Allbrook in a muddy runnel in the Olga Plain, Tasmania, have the following dimensions:

| L | H | D | L | H | D |
|-----|-----|-----|-----|-----|-----|
| 3.9 | 3.2 | 1.9 | 3.2 | 2.5 | 1.7 |
| 3.6 | 2.8 | 1.8 | 3.0 | 2.4 | 1.4 |
| 3.5 | 2.8 | 1.7 | 2.8 | 2.2 | 1.3 |
| 3.4 | 2.8 | 1.6 | 2.4 | 1.9 | 1.1 |
| 3.3 | 2.7 | 1.7 | 2.2 | 1.7 | 1.0 |

Distribution (fig. 95) and habitat. – *P. tasmanicum* is common in Tasmania, South Australia, Victoria, New South Wales, southern Queensland. It has been collected in rivers, creeks, ponds, ditches and seems to be less frequent or even absent in mountain lakes.

Samples in public collections. –

Queensland. – Permanent Ck. in Condomine R. valley, NE. of Killarney, 28°18'S, 152°22'E, leg. Pon. 1981 (C.128716); Great Dividing Range on Killarney-Croftby Rd., 28°14'S, 152°29'E, leg. Pon. 1981 (AMS C.128681); top of Condomine R. valley, W. slope of Wilson's Peak, nr. Brookstead, 28°15'S, 152°29'E, leg. Pon. 1981 (AMS C.128700); top of Cap Ck., Cunninghams Gap, 28°34'S, 152°23'E, pools and creek, leg. Pon. 1981 (AMS C.128680).

New South Wales. – Hoffman's Ck. and trib., Hervetsons Hill, ca. 14 km E. of Legume, 28°26'S, 152°24'E, leg. Pon. 1981 (AMS C.135445); off trib. to Back Ck., Unumgar State Forest, just below spring in permanent trickle, 28°26'S, 152°42'E, leg. Pon. 1981 (AMS C.128679); ford on Byrill Ck. at Pretty Gully, 28°27'S, 153°14'E (AMS C.135446); Boggy Ck. on Minyon Drive to Minyon Falls, 28°29'S, 153°23'E, large stream, leg. Pon. 1981 (AMS C.128677); small trib. of Peacock Ck. on road to Kyogle, 11 km NNE. of Urbenville Rd. turnoff, 29°41'S, 152°42'S, leg. Pon. 1981 (AMS C.135447); Seven Mile Ck. 11 km W. of Bolivia, New England district, 29°18'S, 152°04'E, leg. Pon. 1981 (AMS C.135448); Deepwater R., N. of Echo Homestead, 29°27'S, 152°00'E, leg. Pon. 1981 (AMS C.128683);

Moomerri Ck., just above junction Nymboida R., N. of Dorrigo, 30°12'S, 152°41'E, leg. Pon. 1981 (AMS C.128703); Mulloon Ck. off Tawarri Track, NW. of Braidwood, 30°23'S, 149°35'E, isolated pools, leg. Pon. 1981 (AMS C.126459); Oxford Falls, Middle Ck., Sydney, 33°44'S, 151°17'E, leg. Wal. 1975 (AMS C.129136); Paddy R. betw. Cotter R. and Tiddinbilla, leg. Ros. 1955 (USNM 623331); stream ½ km S. of Wee Jasper, 35°07'S, 148°41'E, leg. Pon. & Hal. 1980 (AMS C.126966); Burrumbowlie Swamp Ck., Riverside-Tarago Rd., 5.7 km from Shoalhaven R., 35°15'S, 149°50'E, leg. Pon. 1981 (AMS C.126346); Shoalhaven R., Riverside-Tarago crossing, 35°16'S, 149°53'E, leg. Pon. 1981 (AMS C.126347); Shoalhaven R. at Warri Bridge, N. of Braidwood, 35°21'S, 149°44'E, leg. Pon. 1981 (AMS C.126458); Mongarlowe R., on the Clyde R., E. of Braidwood, 35°26'S, 149°56'E, leg. Pon. 1981 (AMS C.126576); Majors Ck., Majors Ck. Rd., S. of Braidwood, 35°33'S, 149°45'E, leg. Pon. 1981 (AMS C.126708); 4 km up Harolds Cross Rd., from Main Rd. 270, NE. of Captains Flat, 35°34'S, 149°34'E, leg. Pon. 1981 (AMS C.126710); Schoolhouse Ck., Gundillion, S. of Braidwood, 35°46'S, 149°38'E, leg. Pon. 1981 (AMS C.135450); Currumbene Ck. on Snowball Rd., 35°54'S, 149°36'E, leg. Pon. 1981 (AMS C.126716); Undooock, at Oak Valley on Countegany-Cooma Rd., 36°04'S, 149°26'E, weedy pools, leg. Pon. 1981 (AMS C.126751); Peppers Ck. crossing nr. Little Badja, 36°06'S, 149°31'E, leg. Pon. 1981 (AMS C.126747); Big Badja R. at Boggy Plain, 36°08'S, 149°28'E, leg. Pon. 1981 (AMS C.126749); ditch to side of Big Badja R., 6 km N. of Countegany, 36°08'S, 149°29'E, leg. Pon. 1981 (AMS C.128098); Guinea Ck. on road just before Badja Forest Rd., off Tuross Rd., 36°11'S, 149°28'E, leg. Pon. 1981 (AMS C.126750); Umaralla R., E. of Numeralla, ca. 36°12'S, 149°20'E, leg. Pon. 1981 (AMS C.126773); Wambrook Ck., W. of Cooma, Snowy Mts. Hwy., Kosciusko Nat. Park, 36°23'S, 148°57'E, leg. Pon. 1981 (AMS C.135451).

Aus. Cap. Territory, Paddy's R., leg. Ros. 1955 (USNM 623331).

Victoria. - Studley Park, leg. Gab. (AMS C.43726); Mitta R./Toke Ck. junction, Dartmouth area, 1974 (NMV); Merri R., bridge at Walsh Rd. nr. Warnambod, leg. Pla. & Gom. 1979 (NMV); Glenelg R. at junction Moleside Ck., type-locality of *P. aslini* n. sp., leg. Asl. 1975 (Asl. Coll.).

South Australia. - Kangaroo Is., Western R., 4.5 km NNW. of Gosse, leg. Zei. c.s. 1981 (SAM TD 3584; ZMA/K 23043).

Tasmania. - Creek in Brown's R. (AMS C.63898); South Esk R. at Tullochgorum, leg. Nor. 1975 (MUC); several localities in headwaters and plain of Olga R., leg. Lak., Com., All., Ric., Swa. 1976 (MUC); Coal R. at Campania, leg. Slo. 1977 (ZMA/K 21007); Eagle Ck., Gordon R., leg. Dav. 1937 (AMS C.109828); Lake Edgar, leg. Dar. 1968 (TMH; ZMA/K 18696); Lake Edgar (now part of the impounded Lake Pedder), leg. Tyl. 1972 (ZMA/K; Meier-Brook Coll.); Fish Ponds, Plenty, leg. Mol. 1965 (TMH E.10985; ZMA/K 23034).

9.07 *Pisidium carum* (Cotton)

fig. 47, 54-57, 90

1953 *Australpera cara* Cotton, p. 21, pl. 2, f. 2.

1961 *Australpera cara*, - Cotton, p. 189, f. 188.

Description. - Shell relatively thick and strong, not transparent, densely porous (about 120 irregularly spaced pores per ¼ square mm), dull shining, horn colour. Outline rounded pentagonal, rather high (H.i. 88) moderately swollen (C.i. 32); upper margin long, slightly curved, marked at its extremities by rounded angles, the part of the upper margin behind the beaks as long as the part before it; front margin strongly curved just below the horizontal median plan; back margin truncated, passing gradually into the regularly rounded ventral margin. Beaks moderately high, slightly flattened on their tops. Sculpture: fine, concentric, regularly spaced striae (8-10 per ½ mm). Hinge-plate solid, long, the distance between the cusps of A1 and P1 being about 4/7 of the shell-length; lateral teeth thick, short, with blunt cusps (profile view) and nearly equally long inner and outer slopes; cardinal teeth small, C2 and C4 short, slightly curved, parallel; C3 obliquely situated on hinge-plate, bifid, slightly curved. Ligament internal, not visible exteriorly; ligament-pit short, about 1/7 of shell-length. Muscular impressions: posterior

adductor impression roundish, situated somewhat lower than the larger and oval anterior adductor impression, both crossing the horizontal median plan. Dimensions: L 3.4, H. 3.0, D 1.9 mm, L 4.2, H 3.6, D 2.4 mm (AMS C.109830).

Distribution (fig. 90) and habitat. – Known from some localities in South Australia, Tasmania and New South Wales. Seems to inhabit mainly streams, not stagnant water.

Samples in public collections. – Brownhill Creek, western slopes of the Mount Lofty Ranges, S.A., leg. Cot. (SAM D.14454, type-lot). – River Torrens, S.A. (Cotton, 1961: 190). – Launceston, Tasmania (AMS C.109827). – Kings Creek, trib. of McIntyre R., northern N.S.W. (AMS C.109825). – Nadgengutta Ck., NE. of Braidwood, N.S.W., 35°10'S, 150°04'E, weedy mud-sand bottom, leg. Pon. 1981 (AMS C.126349). – small stream under bridge on Bombay Rd., at Braidwood, N.S.W., 35°29'S, 149°29'E, leg. Pon. 1981 (AMS C.135456). – Darling River, N.S.W. (AMS C.109830).

Remarks. – In my files I had described this form as a new species dedicated to Dr. Ponder whose thorough fieldwork has much contributed to our knowledge of the sphaeriid fauna of eastern Australia. The preceding description was based on a specimen (fig. 55) from the Darling River, N.S.W. (AMS C.109830). However, shortly before finishing the manuscript Mr. Zeidler enabled me to study the "holotype" of *Australpera cara* Cotton (SAM D.14454), which turned out to be the same species as that of the Darling River. The "holotype" of *P. carum* consists of two shells, both gummed on cardboard, viz., a complete (closed) shell at left and a right valve at right. Since a holotype can only be a single individual, I herewith select the right valve as lectotype (fig. 47). Consequently, the left specimen becomes a paralectotype. The dimensions of the lectotype (L 3.9, H 3.5, D 1.2 mm x 2) correspond with Cotton's statement. Cotton's figures of *P. carum* are not very accurate, and resemble a *Sphaerium* more than a *Pisidium*.

P. carum is completely different from the other Australian pisidia. Exteriorly it looks like a large *P. tasmanicum*, from which it is distinct by the thick shell and the heavy hinge-plate. The largest specimen known measures L 4.6, H 3.9, D 2.9 mm, C.i. 37, H.i. 85 (Kings Creek). The two specimens from Launceston (fig. 54) have higher beaks (H.i. 90 and 93 respectively) than the type. The specimen shown in fig. 55 has an irregularly shaped, somewhat flattened beak.

The dentition is variable (figs. 47, 54, 55), but C3 is always long, hooked and bifid at its posterior end.

More fieldwork and research are necessary in order to know more on its ecology, affinities and geographical distribution.

9.08 *Pisidium kosciusko* (Iredale)

figs. 70-73, 94

1943 *Glacipisum kosciusko* Iredale, p. 197.

1943 *Glacipisum kosciusko*, – Iredale, p. 95, f. 3.

1961 *Glacipisum kosciusko*, – Boettger, p. 232.

1980 *Glacipisidium kosciusko*, – Timms, p. 120.

1980 *Glacipisum kosciusko*, – Timms, pp. 119, 121, 123.

Description. – Shell thin, but not transparent, circular-ovate, relatively high (H.i. 82-90), moderately compressed (C.i. 30-36). Beaks broad, low, submedian (fig. 71). Dorsal margin marked with weak angles at its extremities. Ventral margin broadly curved. Sculpture: fine concentric striation and several growth ridges, periostracum dull. Hinge-

plate narrow, moderately long, the distance between the apices of A1 and P1 being slightly more than half the shell-length. Inner lateral teeth long and sharp, in profile with long proximal and steep distal slopes; outer lateral teeth (A3 and P3) short and narrow, but well developed. Cardinal teeth: C2 and C4 short, straight, C3 straight, its hind end thickened. Ligament internal, not visible exteriorly. Ligament-pit narrow, about $\frac{1}{6}$ of shell-length.

Dimensions (in mm) of specimens dredged 10.II.1977 by Dr. Timms in the type-locality, the Blue Lake, N.S.W., at 8 m depth:

| L | H | D | C.i. | H.i. | L | H | D | C.i. | H.i. |
|-----|-----|-----|------|------|-----|-----|-----|------|------|
| 4.3 | 3.7 | 2.5 | 34 | 86 | 3.6 | 3.2 | 2.0 | 31 | 89 |
| 4.0 | 3.4 | 2.0 | 28 | 85 | 3.5 | 3.0 | 1.8 | 30 | 86 |
| 3.9 | 3.2 | 1.9 | 28 | 82 | 3.5 | 3.0 | 2.0 | 33 | 86 |
| 3.7 | 3.2 | 2.3 | 36 | 86 | 3.2 | 2.7 | 1.9 | 35 | 84 |
| 3.7 | 3.2 | 2.2 | 34 | 86 | 3.1 | 2.8 | 1.7 | 30 | 90 |

Distribution (fig. 94) and habitat. – Lakes, creeks and pools on alpine level in New South Wales. In the glacial lakes it lives at different depths down to 26 m.

Samples in public collections. – Blue Lake, leg. Ros. 1955 (USNM 623248), leg. Tim. 1980 (ZMA/K 21309), Club Lake, leg. Tim. 1980 (ZMA/K 21310); Lake Albina, leg. Ros. 1955 (USNM 623249); Spencer's Ck., nr. Main Rd., leg. Ros. 1955 (USNM 623244); Spencer's Ck., $\frac{1}{2}$ mile from Bett's Camp, 5800 ft. alt., leg. Ros. 1955 (USNM 623245); Bett's Ck., pools nr. bridge on main road to Mt. Kosciusko, leg. Ros. 1955 (USNM 623247); Wilkinson's Valley nr. Mt. Kosciusko, approx. 6200 ft., in shallow pool, leg. Ros. 1955 (USNM 623243).

The Blue Lake is the type-locality (AMS C.100523, holotype; AMS C.21790, 5 paratypes).

Remarks. – Timms (1980) collected large numbers of *Pisidium* at different depths in the following lakes: Blue Lake (1890 m.s.m.), Club Lake (1950 m.s.m.), Lake Albina (1920 m.s.m.) and Cootapatamba Lake (2070 m.s.m.). He kindly submitted to me some series for identification. I labelled the Blue Lake series *P. kosciusko* and the series from the three other lakes *P. tasmanicum*, but after having seen more samples from the Snowy Mountains, these identifications do not satisfy me any more. As a matter of fact, the specific identity of *P. kosciusko* still puzzles me. On the one hand it reminds one of certain forms of the variable *P. casertanum*, on the other hand it could be a form of *P. tasmanicum*. *P. casertanum* generally has an arched or hooked C2, whereas C4 is short and straight, and C3 slightly curved. In *P. kosciusko* all cardinals are short and straight as in *P. tasmanicum*, but its sculpture is not as delicate as in the latter. The series collected by Timms in the Blue Lake show a slight dimorphism of the shells. On the one hand there are roundish-oval, somewhat convex forms, on the other hand, thin and more elongate forms, both connected by intermediates.

As long as doubt exists, it seems better to maintain Iredale's name for the alpine lake form. Whatever the identity of *P. kosciusko* may turn out to be, there is no reason at all to consider it a representative of a separate genus as Iredale did, nor even a subgenus.

Further study, among others on morphometric and statistical bases of large series of *Pisidium* from all kinds of water bodies in the Snowy Mountains may perhaps solve the problem of the relationships of *P. kosciusko*, *P. tasmanicum* and *P. casertanum*.

9.09 *Pisidium casertanum* (Poli)

figs. 48-53, 91

- 1791 *Cardium casertanum* Poli, p. 65, pl. 16, f. 1.
 1883 *Pisidium Etheridgei* Smith, p. 306, pl. 7, f. 35.
 1887 *Pisidium Etheridgei*, - Tate, p. 99.
 1893 *Pisidium Etheridgei*, - Adcock, p. 12.
 1893 *Pisidium etheridgei*, Kew, p. 63.
 1936 *Pisidium etheridgei*, - Cotton, p. 85, f. 47.
 1938 *Pisidium etheridgei*, - Cotton & Godfrey, p. 179.
 1939 *Pisidium etheridgei*, - Gabriel, p. 129, pl. 4, f. 37.
 1943 *Australpera mena* Iredale, p. 95, f. 3.
 1943 *Australpera etheridgei*, - Iredale, p. 196.
 1954 *Pisidium etheridgei*, - Fernando, p. 17.
 1961 *Australpera etheridgei*, - Cotton, p. 189, f. 187.
 1961 *Pisidium etheridgei*, - Boettger, p. 232.
 1962 *Pisidium casertanum*, - Herrington, p. 34.

Description. - Shell oval, tending to subtrigonal, inequilateral, moderately convex (C.i. 33-35), opaque, densely porous, dull shining. Anterior margin sharply curved, posterior margin broadly rounded, ventral margin regularly curved, dorsal margin relatively long, more than half the shell-length. Beaks submedian. Sculpture, fine or faint, irregularly spaced concentric striae. Hinge moderately long, relatively broad in its central part. Inner lateral teeth well developed, outer lateral teeth much shorter, parallel to the inner laterals. Cardinal teeth: C2 arched, C4 straight, short, obliquely behind C2; C3 longer than the left valve cardinals, arched, its posterior end thickened. Ligament not visible exteriorly. Ligament-pit rather broad and long, about $\frac{1}{5}$ of the shell-length, its inner margin very curved.

Remarks. - *Pisidium casertanum* is the only species of the genus considered to be of worldwide distribution. However, whereas it is frequent, numerous and polymorphous in Holarctis, its distribution in South America, Africa and Southeast Asia is discontinuous and restricted to high mountains where it lives in water-courses, rarely in lakes. It is not rare in New Zealand (Kuiper, 1967) and it has often been recorded in Australia. In the Australian samples I had the opportunity to study, its specific delimitation against *P. tasmanicum* on the one hand, and *P. hallae* n. sp. and *P. kosciusko* on the other hand, is not always clear. Much field work still has to be done to solve this taxonomic problem. In localities where two or more of these species live together, large series should be collected for statistical study of morphometric gaps.

Ellis (1940: 57; not in later editions) noted: "*P. meridionalis* from Tasmania appears to be identical with *cinereum* and may have been introduced". I do not know, what he means by *P. meridionalis*, probably it is an error. *P. cinereum* is a junior synonym of *P. casertanum*.

Smith (1883: 128) noticed with respect to *P. etheridgei* "not unlike the European *casertanum*, but rather less inequilateral". Herrington (1962) mentioned the presence of *P. casertanum* in the Australian area.

The types of *P. etheridgei* Smith (1883) are, in my opinion, good examples of Australian *P. casertanum*, with the exception of the largest specimen (L 6.5 mm) which belongs to *S. tasmanicum*, the only specimen with a "distinct apical cap" (Smith, 1883: 307). The other five type-specimens (BML 78.2.15.5), of which I herewith designate no. 2 as lecto-type of *P. etheridgei*, have the following dimensions in mm:

| | | | |
|----|-------|-------|--------------------|
| 1. | L 5.0 | H 4.3 | D 3.0 mm |
| 2. | L 4.3 | H 3.5 | D 2.3 mm (fig. 49) |
| 3. | L 4.1 | H 3.5 | D 2.4 mm |
| 4. | L 3.3 | H 2.8 | D 1.9 mm |
| 5. | L 3.3 | H 2.6 | D 1.8 mm |

The shape of the lectotype is in agreement with the figure in Smith (1883, pl. 7, f. 35). On the other hand, Cotton & Godfrey's (1938: 178, f. 182) illustration of *P. etheridgei*, reproduced in Cotton (1938: 85, f. 35; 1961, f. 187) is wrong.

The type-lot of *Australpera mena* Iredale (AMS C.63905) consists of four shells which, in my opinion, belong to *P. casertanum*. Iredale's measurements (1943: 95 "only 3 by 2 mm") are not quite exact. The dimensions of the type-specimens are:

| | | | |
|----|-------|-------|-------------------------|
| 1. | L 4.0 | H 3.4 | D 2.4 mm |
| 2. | L 3.8 | H 3.2 | D 2.4 mm (fig. 53) |
| 3. | L 3.4 | H 2.8 | D 2.0 mm |
| 4. | L 3.3 | H 2.7 | D 1.4 mm (single valve) |

No. 2 is herewith designated lectotype of *Australpera mena*.

Iredale (1943a: 196) created a new genus, *Australpera*, with *Pisidium etheridgei* as type-species. His description runs: "the characteristic external ligament in *Pisidium* is missing here, and the teeth are so unlikely that they have been suggested as of Lasaeid relationship, while the shell is fragile, unlike the northern forms". Cotton (1961: 189) notes that the hinge-teeth of *P. etheridgei* recall "those of the genus *Kellia* Turton 1822"; he also writes about "the characteristic external ligament of *Pisidium*". I must admit that I do not understand anything of this, but it is evident that neither Iredale nor Cotton have examined authentic specimens of *P. etheridgei* and that both authors had erroneous ideas about it.

Variability. - In Australia the variability of this species is limited compared to that in Europe. Its outline may be more rounded (fig. 48), or somewhat lower (fig. 52) than the types of *P. etheridgei* (fig. 49). Specimens with more regular, sometimes silky, striation are reminiscent of *P. tasmanicum*. The beaks may be more or less broad.

Distribution (fig. 91) and habitat. - *P. casertanum* is common in the eastern states and in Tasmania, but seems to be discontinuously distributed. It lives in all kinds of streams as well as in pools and bogs, sometimes associated with *P. tasmanicum* or *P. hallae*.

P. casertanum is the most euryecious species of the genus. It lives in eutrophic as well as in oligotrophic, in stagnant as well as in running water and tolerates rapid changes in water-temperatures (section 5). It is sometimes numerous in *Sphagnum*-bogs and seems to be the only *Pisidium* with a tolerance limit of pH 4.5 (Økland & Kuiper, 1982). Miss Jenny McAuley (M.U.C.) wrote (4.VIII.76) the following note on specimens which I had identified as *P. casertanum*: "They were collected from a *Sphagnum* bog on Mt. Baw Baw, Victoria (37°50'32"S, 146°16'30"E) at an altitude of 1500 m. They occur in the pods of water between the *Sphagnum* mounds, but are most common in and around the *Sphagnum* growing in the running of the bog. They are often almost buried in the organic mud at the mud/water interface. These specimens were collected last summer (30.12'75) when I recorded water temperatures of up to 24°C. I have found them in each sample since then and the last time I visited the bog (mid-July) it was almost completely covered with snow, the pods were iced over and the temperature of the running water was about 1.5°C. Noteworthy is, that the specimens are not depauperate at all, as witnesses well-grown

shells of nearly 5 mm length". – Analogous observations have been made in "pozzines" at an altitude of 2000 m in the Pyrenees (Combes et al., 1971: 118).

Samples in public collections.

Queensland. – Top of Gap Creek, Cunninghams Gap, in pools and creek, 28°34'S, 152°23'E, leg. Pon. 1981 (AMS C.135452).

New South Wales. – Seven Mile Ck., 11 km W. of Bolivia, New England district, 29°18'S, 152°04'E, leg. Pon. 1981 (AMS C.135449); small stream under bridge on Bombay Rd., at Braidwood, 35°29'S, 149°49'E, leg. Pon. 1981 (AMS C.135453); Tallaganda State Forest, trib. of Round Mountain Ck., on Crow Valley Rd., 35°39'S, 149°31'E, leg. Pon. 1981 (AMS C.128104); creek on Crow Valley Rd. in Tallaganda State Forest, 35°42'S, 149°32'E, leg. Pon. 1981 (AMS C.128102); Reedy Ck., trib. of Shoalgaven R., 6 km E. of Marble Arch Rd., from Braidwood, 35°43'S, 149°41'E, leg. Pon. 1981 (AMS C.128103); Schoolhouse Ck., Gundillion, S. of Braidwood, 35°46'S, 149°38'E, leg. Pon. 1981 (AMS C.128101); creek 5.5 km NW. of Adaminaby, Snowy Mts. Highway, 35°59'S, 148°44'E, leg. Pon. & Hal. 1980 (AMS C.128108); small swampy trib. of Big Badja R., 2 km N. of Badja, on Gundillion Rd., 36°03'S, 149°32'E, leg. Pon. 1981 (AMS C.135454); small swampy creek in open woodland, ½ km N. of Alpine Ck. on Snowy Mts. Highway, Kosciusko Nat. Park, leg. Pon. & Hal. 1980 (AMS C.126962); lake by Bett's Ck., Mt. Kosciusko Rd., leg. Smi. 1969 (NMV); Glenshiel Station, Llangothlin, New England distr., 4300', head of Ollera Ck., trib. of Gwydir R., leg. Dar. 1944 (AMS C. 4300; ZMA/K 15003); Wambrook Ck., W. of Cooma, Snowy Mts. Highway, Kosciusko Nat. Park, 36°23'S, 148°57'E, leg. Pon. & Hal., 1980 (AMS C.128106).

Victoria. – *Sphagnum* bog on Mt. Baw Baw, leg. Mca. 1975 (ZMA/K 20.608); Talbot Peak, Mt. Baw Baw, leg. Gab. (AMS C.43726); *Sphagnum* bog between Mt. Erica and Talbot Peak, alt. 4800', leg. Bar. 1973 (NMV); Mississippi Ck., Colquhoun Rd., 6 km NW. of Lakes Entrance, leg. Pla. 1976 (NMV); Acheron R., 18 km E. of Healesville, 1975 (ZMA/K 22771); Mitta R./Toke R. junction, Dartmouth area, 1974 (NMV); Cape Liptrap area, 1972 (NMV).

South Australia. – Kangaroo Is., Larrakin Lagoon (SAM D.3587; ZMA/K 23046).

Tasmania. – Lake Crescent at Clyde R. mouth, leg. Mol. 1963 (TMH E. 10983; ZMA/K 23036); Eden Ck., Florentine Valley, leg. Mol. 1961 (TMH E. 1935); Launceston, leg. Pet. (AMS C.27758; ZMA/K 15010); creek nr. Brown's R. (AMS C.63898), associated with *P. tasmanicum*; small, deep pond at Knocklofty, W. of Hobart, 42°53'S, 147°18'E, leg. Pon. & Dar. 1970 (AMS C.129134); dune pool Ocean beach, W. of Strahan, leg. Mcm. 1972 (ZMA/K 19636); Lake Skinner, alt. 3000 ft., leg. Kig. 1939 (TMH E.5196).

9.10 *Pisidium hallae* n. sp

figs. 78-81, 93

Diagnosis. – Distinct from the other Australian species of *Pisidium* by its lower, oval shape, its clearly postmedian beaks and its faint, irregular striation.

Description. – Shell oblong-oval, thin, subtransparent. Front margin somewhat more pointed than back margin, densely porous. Beaks low and relatively broad, perpendicular, situated postmedian on about 1/3 of the shell-length. Surface of the shell dull glossy, irregular and faintly striated. Hinge-plate narrow, length about half the shell-length; distance between the cusps of A2 and P2 = 1.7 mm. Hinge teeth: A2, outer and inner slopes evenly steep; P2 outer slope nearly vertical, inner slope soft, cusps blunt; A1 and P1, cusps pointed, inner and outer slopes feeble; A3 and P3 short, low, parallel to the inner laterals A1 and P1 respectively; C2 and C4 short, C4 straight, length 0.15 mm, obliquely situated behind the very short (0.1 mm) and curved C2; C3 length 0.2 mm, parallel to the margin of the hinge-plate, back part strongly arched down. Ligament-pit moderately long, length 0.55 mm. Dimensions of holotype: L 3.4, H 2.8, D 2.0 mm.

Type locality. – Yarrangobilly River at Cave Road, off Snowy Mountains Highway, N.S.W., 35°23'S, 148°30'E, fast flowing, rocks, sand, leg. W.F. Ponder and S.J. Hall, 31.X.1980.

Name. - The species is dedicated to Miss Jane Hall, at the time temporary research assistant to Dr. W.F. Ponder of the Australian Museum, Sydney.

Types. - Holotype (AMS C.126964). Paratypes: 13 specimens (AMS C.135457), 5 specimens (BML), 5 specimens (SMF 192901), 5 specimens (ZMA/K 23050).

Distribution (fig. 93) and habitat. - The Blue Mountains and the New England Mountains (N.S.W.), some localities in Victoria and Tasmania. Seems to inhabit mainly rivers, as well as sandy and swampy creeks, some records in pools with stagnant water.

Samples in public collections.

New South Wales. - On side of McIntosh's Rd., 0.4 km W. of Back Ck. Rd.-junction, in Unumgar State Forest, 28°25'S, 152°41'E, nr. spring, leg. Pon. 1981 (AMS C.128678; QM MO.10353); boggy creek, on Minyon Drive to Minyon Falls, large stream, 28°29'S, 153°23'E, leg. Pon. station 103, 1981 (AMS C.135458; QM MO.10352 not identified), associated with *P. tasmanicum*; small sand & rock creek NW. of Mt. Spirabo, 29°20'S, 152°06'E, leg. Pon. 1981 (AMS C.128648; QM MO.10359 not identified); Scrub Yard Ck., NE. of Little Mt. Spirabo, leg. Pon. 1981 (AMS C.128706; QM MO.10379 not identified); Cooleman Caves, Kosciusko Nat. Park, 32°38'S, 148°38'S, leg. Pon. & Hal. 1980 (AMS C.126963); Guinea Ck., on road just before Badja Forest Rd. off Tuross Rd., small swampy creek, 36°11'S, 149°28'E, leg. Pon. 1981 (AMS C.126750); Yandiguinula Ck., ford on fire trail, Tallaganda State Forest, small sandy creek, in mud in pools, 35°30'S, 149°32'E, leg. Pon. 1981 (AMS C.126712); tributary of Harolds Cross Ck. on Harolds Cross-Rossi Rd., leg. Pon. 1981 (AMS C.126711); Marble Arch, S. of Braidwood, in gravel in pools, 35°44'S, 149°41'E, leg. Pon. 1981 (AMS C.126575; ZMA/K 23022); swampy pool 1.7 km W. of Adaminaby on Snowy Mts. Rd., 36°00'S, 148°42'E, leg. Pon. & Hal. 1980 (AMS C.126965); in swampy creek with few pools on Snowball Rd., 35°55'S, 149°35'E, leg. Pon. 1981 (AMS C.126715); Currumbene Ck. at Minuma hange Fire Trail, Shoalhaven R. System, in pool, 35°58'S, 149°36'E, leg. Pon. 1981 (AMS C.126717); small, swampy creek in open woodland ½ km N. of Alpine Ck. on Snowy Mts. Highway, Kosciusko Nat. Park, leg. Pon. & Hal. 1980 (AMS C.135459), associated with *P. casertanum*.

Victoria. - *Sphagnum* bog near Tatra Inn, Mt. Buffalo National Park, leg. Smi. 1978 (NMV).

Tasmania. - Junction of Gordon and Franklin Rivers, leg. Com., Lak., All., Ric., 1976 (MUC, UTH); runnel on Olga Plain, nr. headwaters of Olga R., leg. Com., All., 1976 (MUC, UTH).

Remarks. - When associated with *P. tasmanicum*, *P. hallae* is distinguished by its lower shape and its sculpture; when together with *P. casertanum*, *P. hallae* which has about the same sculpture and dull surface, is recognizable by its lower and more oblong shape. The largest specimen of *P. hallae* recorded measures L 4.4, H 3.4, D 2.4 mm, but generally the shells are smaller.

The morphological, ecological and geographical delimitation of *P. hallae* against *P. casertanum* should be a topic of closer investigation. Are *P. casertanum* and *P. hallae* ecologically vicariant forms or do they occur together at times without intermediates?

9.11 *Psidium fultoni* n. sp.

figs. 74-77, 92

Diagnosis. - Distinct from the other Australian psidia by its relatively high and laterally compressed shape, by the pronounced edge at the transition of the upper and back margins and by its rather long inner posterior lateral teeth.

Description. - Shell thin but not transparent, porous (about 70 pores per 1/4 square mm), pores irregularly spaced, yellowish-grey. Outline obliquely rounded pentagonal, relatively high (mean H.i. 86), compressed (mean C.i. 27), uoer margin long, marked at its extremities by rounded angles, the part behind the beaks clearly longer than the part

before it; front margin strongly curved below the horizontal median plan, its upper part being straight; back margin gradually passing into ventral margin and forming a regular curve. Beaks low, as high as the central part of the hinge-plate. Sculpture: microscopical fine, concentric lines which have a faint granular surface (enlargement 150 x), causing a silky gloss. Hinge-plate narrow in its central part, rather long (distance A1-P1 more than half the shell-length); lateral teeth P1 and P2 long, straight, narrow, low in profile, with long proximal and steep distal slopes; A1 and A2 slightly curved inward; A3 and P3 parallel to A1 resp. A3, short but well developed; cardinal teeth: C2 narrow, situated at the inner edge of the hinge-plate, slightly curved, length $\frac{5}{20}$ mm (shell-length 3.6 mm); C4 very narrow, slightly curved, situated behind C2; C3 long, $\frac{7}{20}$ mm in length, posteriorly bifid. The distance between P1 and C3 is twice as long as between A1 and C3. Ligament internal, not visible exteriorly; ligament-pit narrow, about $\frac{1}{7}$ of shell-length. Muscular impressions: posterior adductor impression roundish, subtriangular, glossy, situated below the horizontal median plan; anterior adductor impression larger than posterior, oval, glossy, entirely situated above the horizontal median plan.

Measurements holotype: L 3.6, H 3.1, D 1.7 mm.

Dimensions in mm:

| L | H | D | C.i. | H.i. | L | H | D | C.i. | H.i. |
|-----|-----|-----|------|------|-----|-----|-----|------|------|
| 3.8 | 3.2 | 2.0 | 31 | 84 | 2.4 | 2.0 | 1.1 | 27 | 83 |
| 3.6 | 3.1 | 1.7 | 28 | 86 | 2.2 | 1.9 | 1.0 | 26 | 86 |
| 3.5 | 3.0 | 1.7 | 28 | 86 | 2.1 | 1.8 | 1.0 | 26 | 86 |
| 3.1 | 2.7 | 1.5 | 27 | 87 | 1.8 | 1.6 | 0.8 | 25 | 89 |
| 2.9 | 2.6 | 1.5 | 29 | 90 | 1.8 | 1.5 | 0.7 | 24 | 83 |
| 2.6 | 2.3 | 1.1 | 24 | 88 | 1.6 | 1.3 | 0.7 | 27 | 81 |

Type locality. – Dredged in East Lake (North), which is the eastern part of Arthur's Lake, Tasmania. *S. lacusedes* and *P. tasmanicum* were collected in the same habitat (6.II.1978).

Name. – The species is dedicated to Dr. Wayne Fulton, biologist of the Inland Fisheries Commission, Hobart, Tasmania.

Types. – Holotype (TMH); 4 paratypes in each of the following collections: TMH, AMS C.135460, NMV, BML, LMP, SMF 192865; the other paratypes in the collection of the author (ZMA/K 23072).

Distribution (fig. 92). – At present only known from Arthur's Lake and Lake Sorell, Tasmania, where the species has been recorded at many points by W. Fulton.

Samples in public collections. – Arthur's Lake, at many stations (IFC). – Lake Sorell, at different stations, leg. Ful. 1981 (IFC; ZMA/K 22606-22611).

Remarks. – The values of C.i. and H.i. are subject to some variation (see table). It is noteworthy that in all opened specimens I found a small additional muscular impression, as glossy as and just above the anterior adductor impression. Whether or not this character has a diagnostic value should be the subject of closer investigations.

9.12 *Pisidium aslini* n. sp.

figs. 12, 65-69, 89

Diagnosis. – This, the smallest of the Australian sphaeriids, is distinguished by its exteriorly visible, somewhat protruding ligament.

Description. - Shell tiny, thin, oblong-oval, relatively low, moderately tumid (C.i. 34), subtransparent, greyish. Beaks narrow, low, situated at two thirds of the shell-length, nearly smooth, glossy. Back margin slightly flattened, front margin somewhat pointed. Sculpture: fine, regularly spaced, concentric striae (about 15 per $\frac{1}{2}$ mm). Hinge-plate narrow, about $\frac{2}{3}$ of shell-length, the distance between the cusps of A1 and P1 is about $\frac{3}{5}$ of the shell-length. Lateral teeth: the inner lateral A1 is long and narrow, its cusp lying far distal, its inner slope bending deeply into the lumen of the shell; the outer lateral A3 is very short; P1 and P3 are parallel, long, P3 reaching toward the extremity of the ligament-pit; A2 long, its cusp far distal, inner slope steep; P2, inner slope soft. Cardinal teeth: C2 and C4 short, straight, parallel, C4 somewhat behind C2 which is situated on the inner border of the hinge-plate; C3, double so long as C2 and C4, straight, back thickened. Ligament brownish horn-colour, exteriorly profiling. Ligament-pit narrow, relatively long, $\frac{1}{5}$ of shell-length, slightly extraverted. Anterior adductor impression nearly as large as posterior, but situated much higher.

Dimensions. - L 2.5, H 1.9, D 1.3 mm. The holotype is one of the largest of the type-series. The dried animal has five embryos in its left brood pouch and an equal number in the right one. The length of these embryonic shells is about 0.3 mm.

Type-locality. - Glenelg River (Victoria), left bank, at junction of Moleside Creek. Census grid 2402, FWA 2530, grid ref. 426.308, Portland 1 : 250.000 sheet. Collecting date: 3.I.1975.

Name. - Dedicated to its collector, Mr. Fred W. Aslin, Mont Gambier, S.A.

Distribution (fig. 89). - At present only known from the Glenelg River.

Types. - Holotype (NMV F.31522). Paratypes: 160 specimens (NMV F 31523), 20 specimens in private collection F.W. Aslin, 20 specimens (ZMA/K 22780); 5 specimens in each of the following museums: AMS C.135461, SAM, WAM, TMH E 13349, BML, SMF 192900, USNM, MHNP, RML, FMC.

Remarks. - The age structure of the type-series on the collecting-date 3.1.1975 is shown in fig. 12. The broad top of the curve illustrates the generation born about September 1974. The youngest generation, the free living juveniles from 0.8 to 1.5 mm length, is absent in this series, probably due to the use of a collecting-scoop with large mesh.

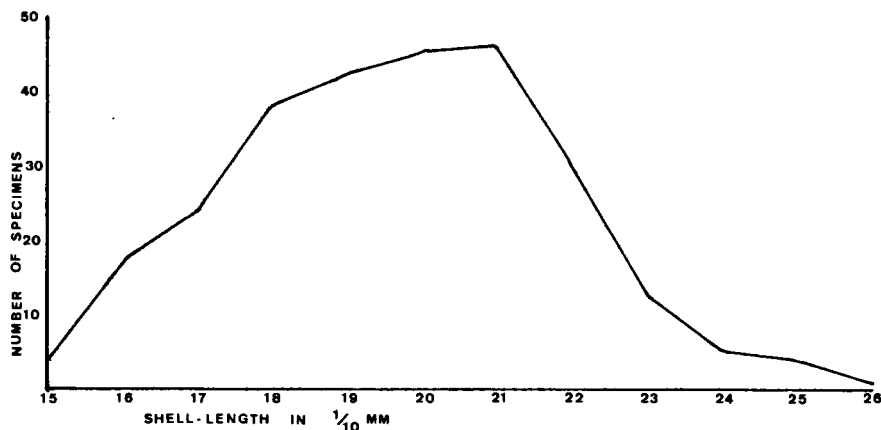


Fig. 12. Frequency curve of shell-length in type-series of *P. aslini*.

Exteriorly *P. aslini* strikingly resembles the European species *P. tenuilineatum* Stelfox. It is evident that this resemblance is one of the multiple cases of convergence in this genus and that it has no taxonomic value at all. These species belong to different subgenera, *P. aslini* with its extraverted ligament-pit being an *Afropisidium*, whereas *P. tenuilineatum* with its introverted ligament-pit is a representative of *Odhneripisidium*.

P. aslini is the smallest species of the subgenus *Afropisidium* (see section 6 and fig. 1). *P. hodgkini*, from New Zealand, grows much larger than *P. aslini*, is less convex and has no sculpture at all. *P. javanum* from Indonesia is twice as long as *P. aslini*. It has a concentric striation as well; its nepionic shell is delicately and concentrically striated and its P3 bends at its inner end towards P1.

In the type-locality *P. aslini* is accompanied by *P. tasmanicum* and by *Corbicula* spec. of which I have only seen juveniles.

MARINE SPECIES FORMERLY ERRONEOUSLY CONSIDERED SPHAERIIDS

9. 13 *Pisidium semen* Menke

fig. 86

- 1843 *Pisidium semen* Menke, p. 40.
- 1844 *Pisidium semen*, - Menke, p. 63
- 1851 *Pisidium semen*, - Petit de la Saussaye, p. 421.
- 1854 *Pisidium semen*, - Bourguignat, p. 53.
- 1854 *Pisum semen*, - Deshayes, p. 284.
- 1858 *Musculium semen*, - Adams, p. 452.
- 1882 *Pisidium semen*, - Tate & Brazier, p. 565.
- 1883 *Pisidium semen*, - Smith, p. 306.
- 1943 *Australpera semen*, - Iredale, p. 195.
- 1964 *Cyclas semen* = *Lasaea* spec., - Kuiper, p. 184.

Menke (1843: 40) published *Pisidium semen* from the banks of the Swan River, describing the shape of the shell only. In another paper (1844: 63) he added a Latin diagnosis and concluded: probably our species belongs to *Cyclas australis*, var. 2 (Lamarck, Hist. Nat. 5: 560) also originating from "Neu Holland". Later authors (Petit de la Saussaye, 1852: 421; Deshayes, 1854: 284; Tate & Brazier, 1882: 565; Smith, 1883: 306) listed *Pisidium semen* in the Sphaeriidae. Adams (1858: 452) classified it, without any comment, with the genus *Musculium*, and Iredale (1943: 196) in his genus *Australpera*, in company of *etheridgei*, *tasmanica* and *dulvertonensis*. It is clear that none of these authors has examined the original specimens, doubtlessly because they were considered to be lost (Dance, 1966: 294). I recovered Menke's cotypes, collected by Ludwig Preiss in 1843, in the Mousson collection (ZMZ). The series consists of four specimens, all about 2.5 mm in length. The epidermis is pale yellow, the sculpture consists of fine, concentric striae, 12-14 on ½ mm, ramified and with irregular interstices (fig. 86a). On the anterior as well the posterior end of the hinge there are purple spots. The hinge-plate is broad, the left and right lateral teeth being strongly developed. The cardinal teeth are rudimentary, one in each valve. The ligament-pit is unlike that of *Pisidium* and completely internal. The mantle-print is not incurved. This species which at a first glance looks like a *Pisidium* belongs to the Leptonidae. It is, in my opinion, a species of *Lasaea*, that seems to be

different from what in Europe is called *L. adansoni* (Gmelin) = *L. rubra* (Mont.). I herewith designate the figured specimen (fig. 86) as lectotype.

Lasaea semen has a striking resemblance to *Arthritica helmsi* (Hedley). Both species have been collected several times in company of *Pisidium*, mostly in tidal zones. Kuiper (1964) lists a number of cases known to him. Probably specimens of *Pisidium* are sometimes washed into the habitat of *Lasaea* and *Arthritica*, or vice versa. The shells recorded by Whan (1894: 9) "in brackish water at Port Fairy" and identified *Pisidium etheridgei* are certainly not that species but probably *Lasaea* or *Arthritica* too.

Dr. Ponder, whom I asked for his opinion on the figured shell of *P. semen* (figs. 86, 86a) noted: "*Arthritica semen* and *helmsi*, if really different species, are certainly congeneric. The hinge, in my opinion, is like that of *Arthritica*, not *Lasaea*, although I agree there is not much difference".

9.14 *Cyclas australis* Lamarck

figs. 82-85

Lamarck (1818, 1835) described *Cyclas australis* from the isle of Timor, N. of Australia, and a smaller variety from "La Nouvelle Hollande" in the harbour of Roi George, where it had been collected by Péron. Menke (1844: 64) thought this species might be identical with his *Pisidium semen* (Menke, 1843). Gray (1851: 82) placed *C. australis* in the synonymy of *Lasaea rubra*. Récluz (1853: 50, pl. 2, f. 4, 5) described and figured specimens probably of Australian origin, which he had received from Bernardi. He called them *Poronia rugosa* n. sp. Bourguignat (1854: 39) listed *Cyclas australis* as a distinct species, classifying it in his "Index du genre *Pisidium*" (l.c., p. 53). Deshayes (1854: 285) called it *Pisum australe* Lamarck. Clessin (1879: 140, pl. 25, f. 7, 8) considered *Pisum australe* sensu Deshayes a *Corbicula*, referring to the Maltzan collection which is now partially in Berlin, partially in London (Dance, 1966: 293). Benthem Jutting (1931) called it *Pisidium australe*. Lamy (1913: 1; Hedley, 1915: 702) revised Lamarck's types preserved in the Museum National d'Histoire Naturelle, Paris, and arrived at the conclusion that *Cyclas australis* Lamarck is a *Lasaea*. Recently Dr. Ponder, whom I asked advice in this matter, wrote to me that *Lasaea australis* (Lamarck), a name widely used in literature, is a very common Australian animal, specifically identical with Lamarck's specimens from Roi George's harbour, whereas the specific identity of the Timor specimens, which also belong to *Lasaea*, is not yet certain.

I have examined Lamarck's type-series. The shells are gummed on strips of cardboard, on which the name and the locality are written by Lamarck. I herewith publish figures of two of the seven shells from Roi George (figs. 83-85), as well as the largest specimen (L 8 mm) from Timor (fig. 82).

The measurements in mm (without D which was not measurable) of the Roi George specimens (from left to right) are:

- | | | | |
|----|-------|-------|----------------------------|
| 1. | L 3.2 | H 3.0 | right valve only (fig. 84) |
| 2. | L 2.9 | H 2.6 | left valve only (fig. 83) |
| 3. | L 3.2 | H 2.8 | left valve only |
| 4. | L 3.1 | H 2.9 | complete shell |
| 5. | L 3.2 | H 2.8 | right valve only |
| 6. | L 3.3 | H 2.8 | left valve only |
| 7. | L 3.2 | H 2.7 | complete shell (fig. 85) |

I herewith designate specimen no. 2 as lectotype of *Lasaea australis* (Lamarck).

10. SYSTEMATIC INDEX (SECTIONS 4-9)

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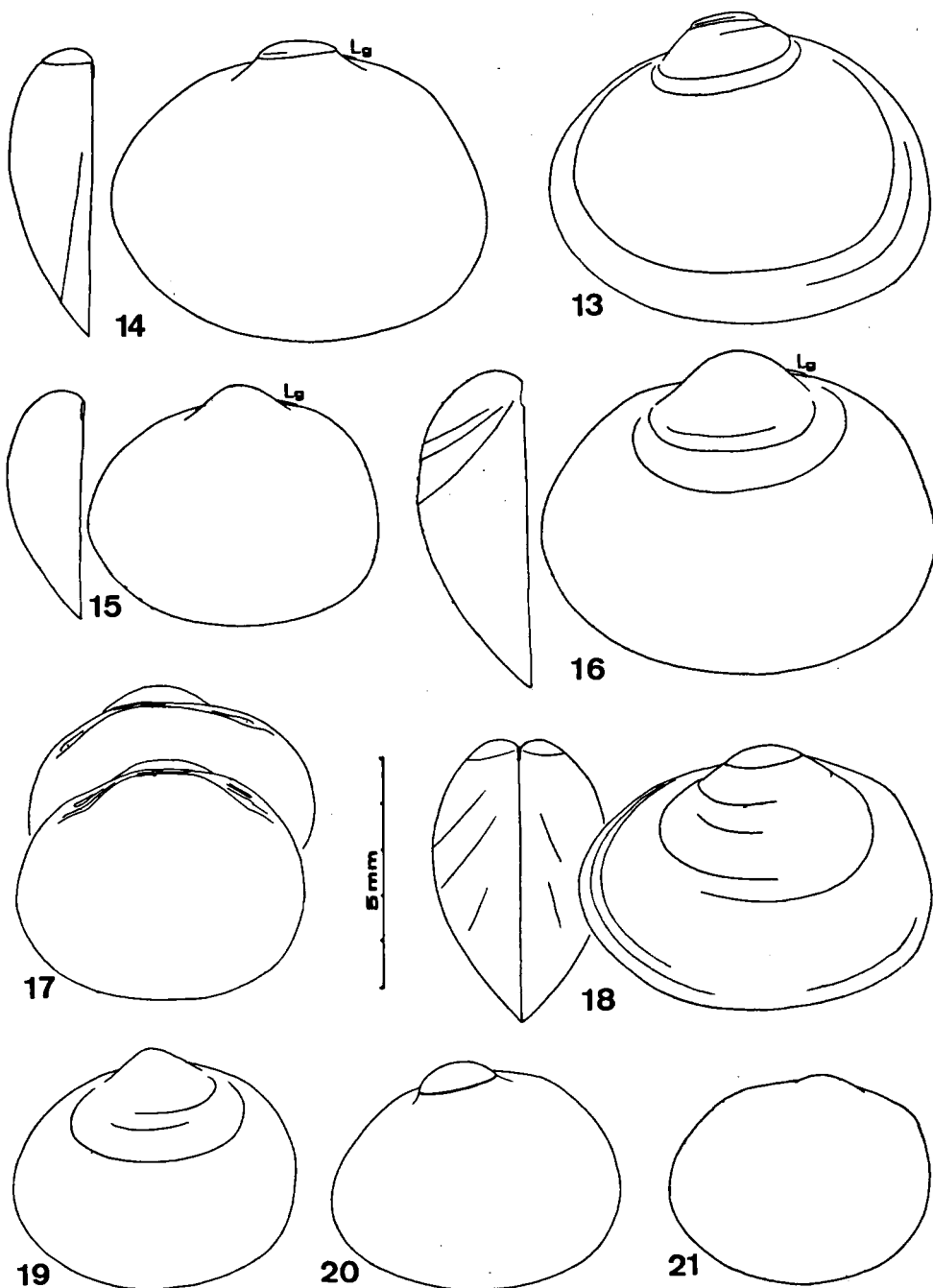
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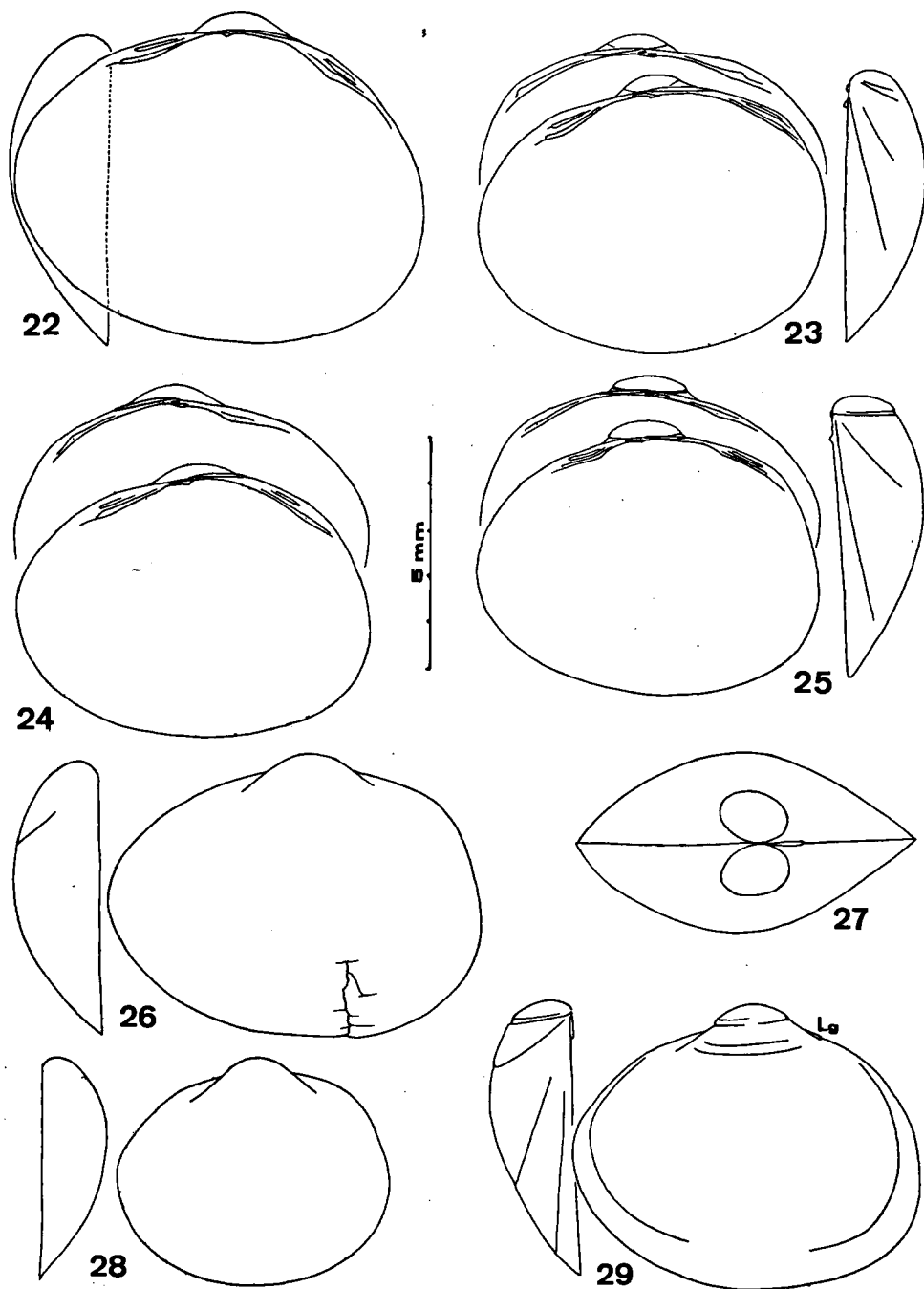
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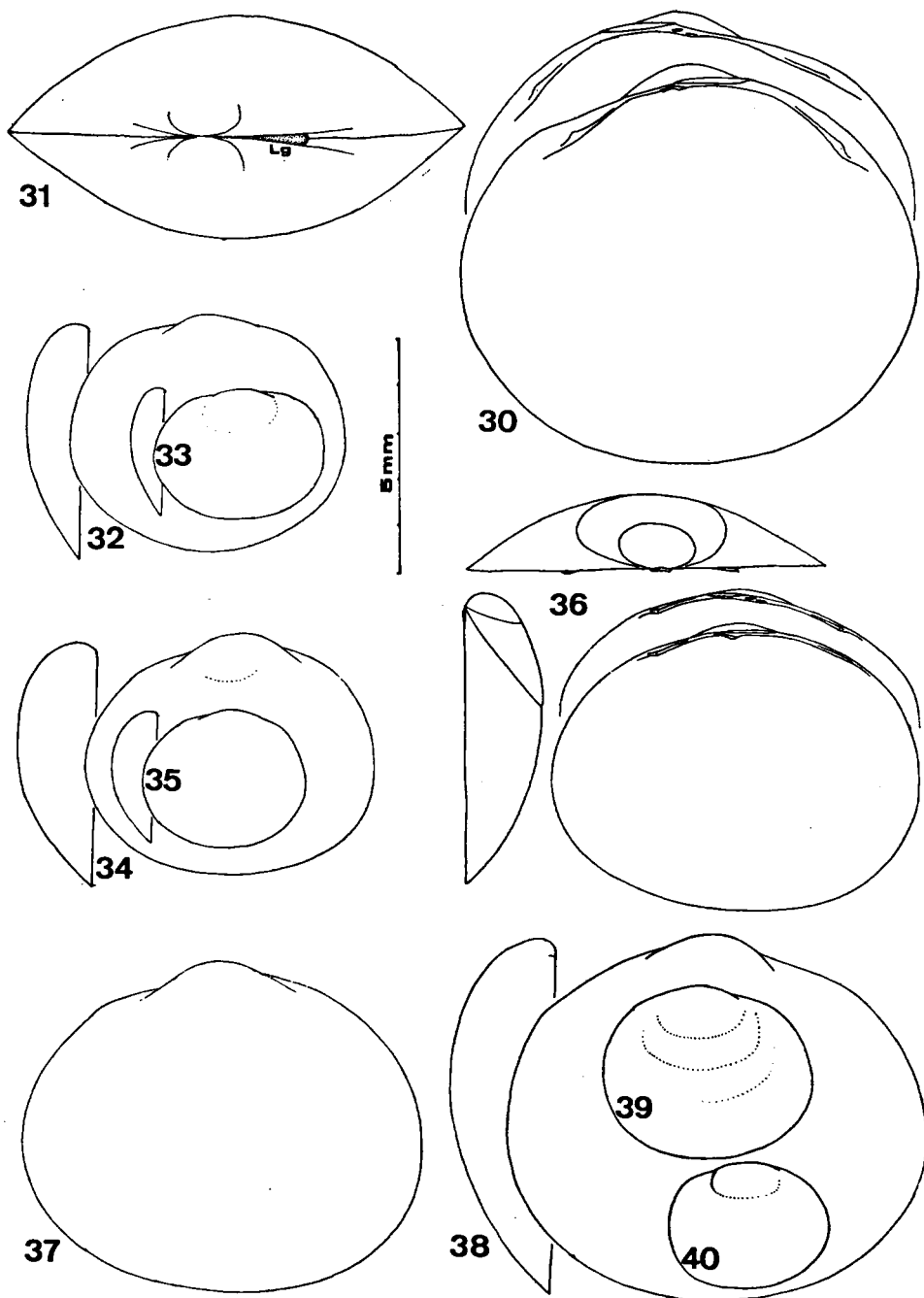
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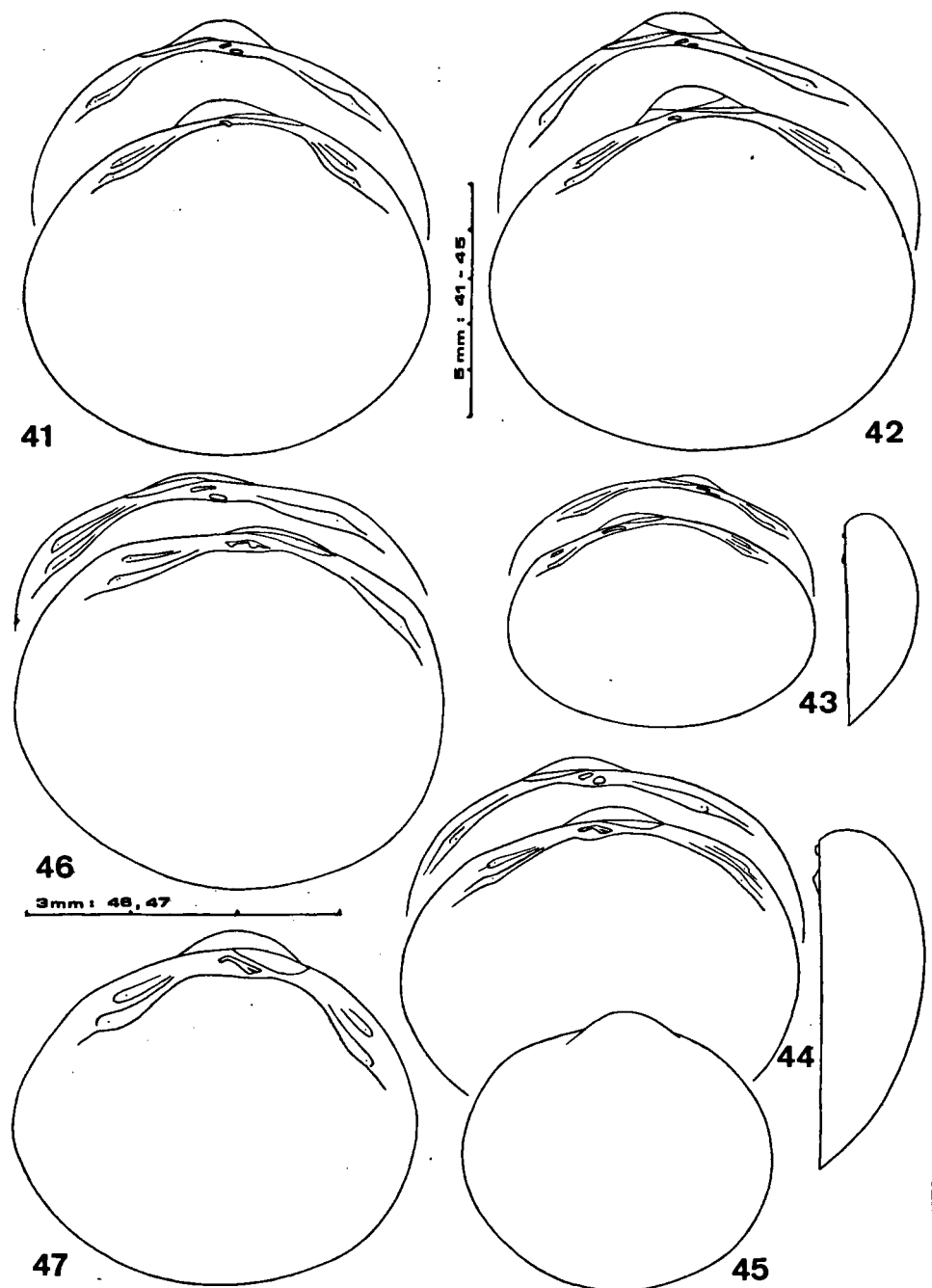
Figs. 13-21. *Sphaerium tasmanicum* (T.W.) from different localities. 13, Wyong Ck., N.S.W., specimen with embryonic cap. 14, Shoalhaven R., N.S.W., specimen with embryonic cap and protruding ligament (Lg). 15, Peel R., Tamworth, N.S.W., specimen without embryonic cap; ligament (Lg) protruding. 16, Shoalhaven R., Braidwood, N.S.W., 17, Arthur's Lake, Cowpaddock Bay, Tas. 18, Lectotype of *Sphaerina nundinalis* Iredale. 19 and 20, Ouse R., Tas., without and with embryonic cap. 21, young individual from Wyong Ck., Wyong, N.S.W.



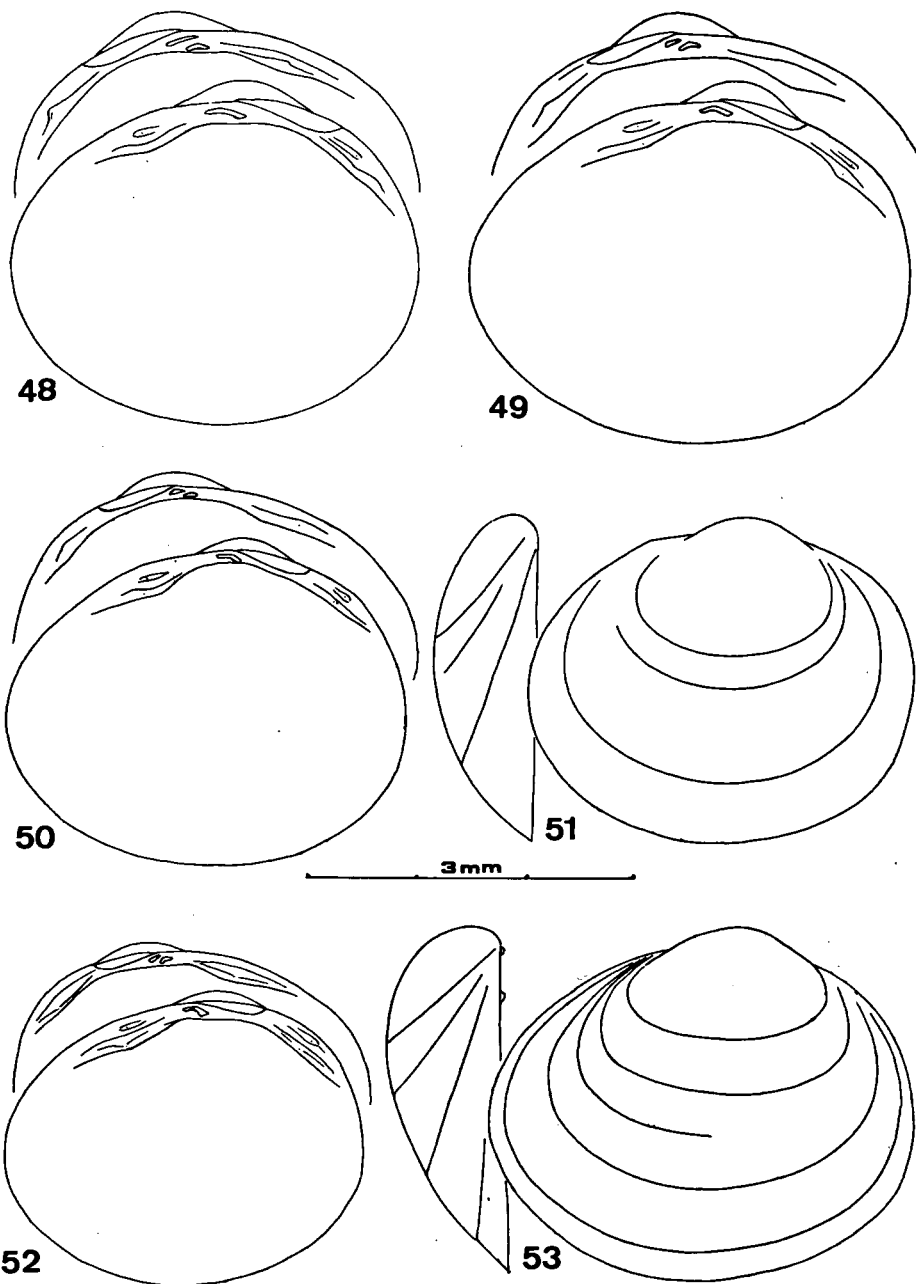
Figs. 22-29. *Sphaerium tasmanicum* (T.W.) from different localities. 22, Holotype of *Australpera bradena* Iredale, Hanging Rock, Nundle, N.S.W. 23, Brogo R., Bega, N.S.W. 24, Shoalhaven R., Braidwood. 25, Ouse R., Tas. 26, Hanging Rock, Nundle, N.S.W., diphyoidic shell. 27, same specimen as 25, dorsal view. 28, Holotype of *Sphaerinova terenda* Iredale. 29, Wyong Ck., Wyong, N.S.W., specimen with marked embryonic cap and protruding ligament (Lg).



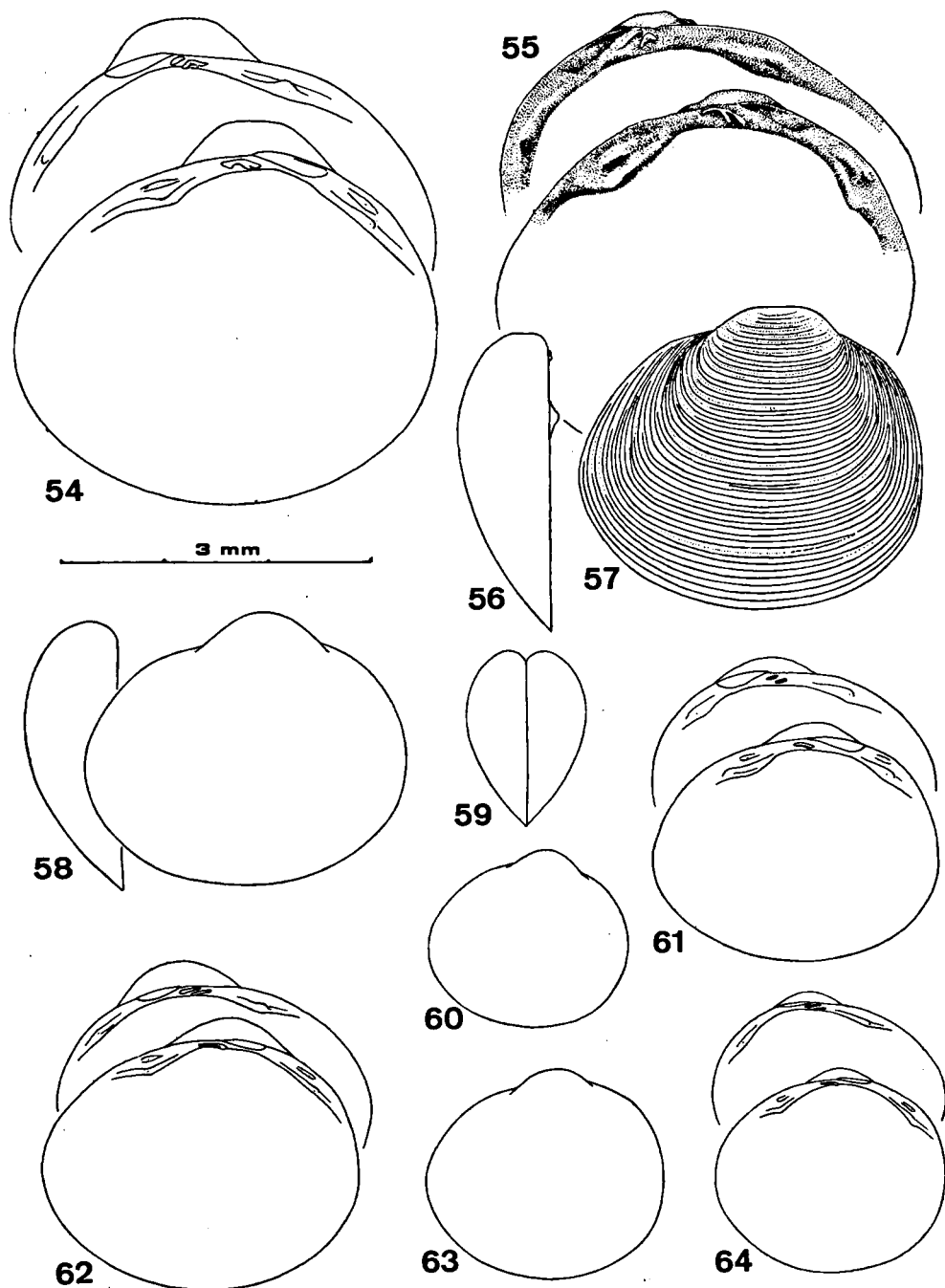
Figs. 30-40. *Sphaerium lacusedes* Iredale. 30, Arthur's Lake, Tas. 31, Dorsal view of same specimen. 32 and 33, Young specimens. 34 and 35, Arthur's Lake, Cowpaddock Bay, slightly convex form with more developed beaks. 36, Great Lake, Cramps Bay, rounded form with very narrow hinge-plate. 37, Great Lake. 38, Arthur's Lake, clearly prosogyrous beaks, long dorsal margin. 39 and 40, Same locality, young shells.



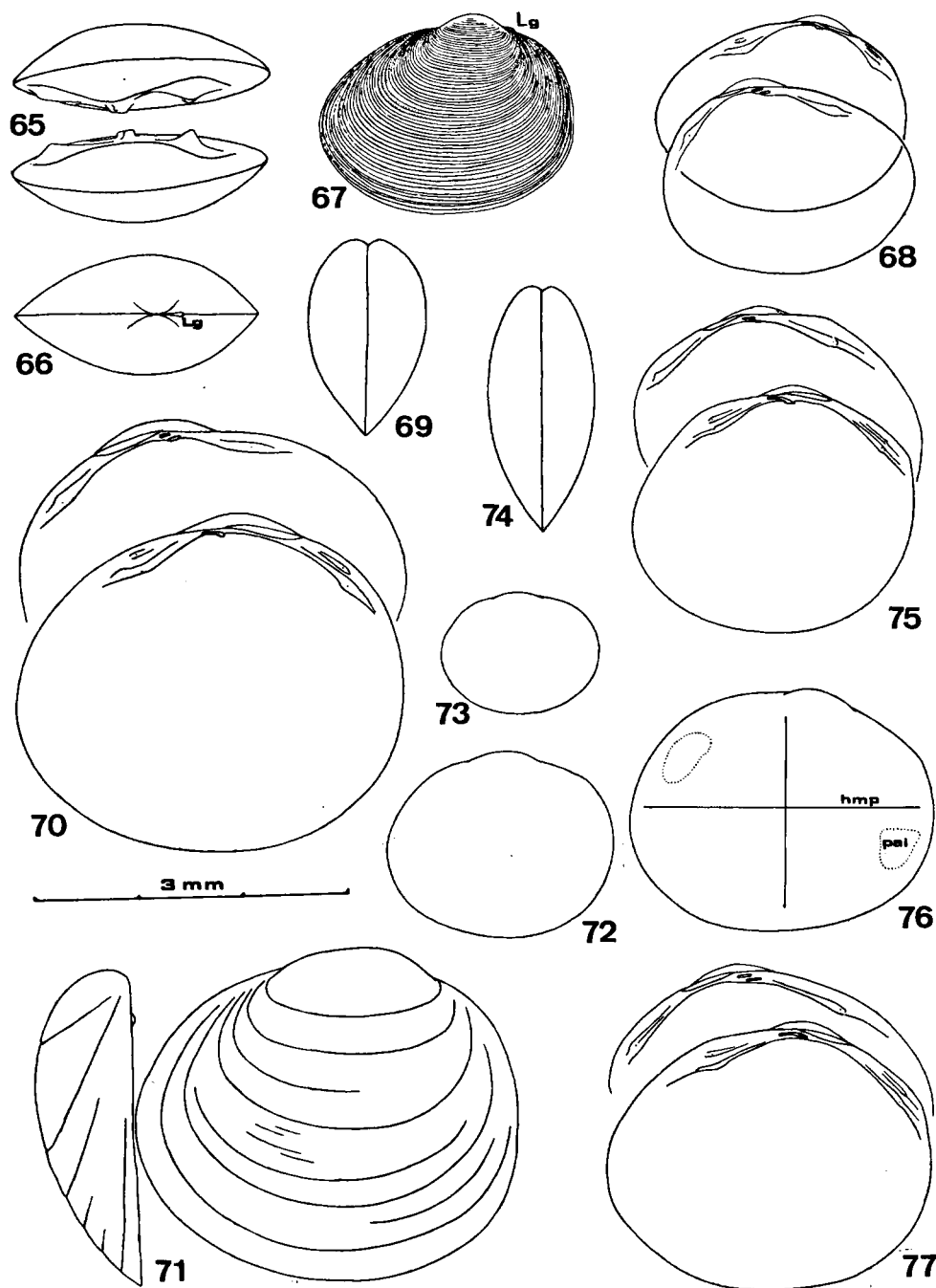
Figs. 41-47. Australian Sphaeriidae. 41-42, *Sphaerium tasmanicum* (T.W.). 41, Holotype of *Sphaerinova tatiarae* Cotton & Godfrey. 42, Holotype of *Sphaerinova bursa* Cotton. 43, Paratype of *Sphaerium problematicum* Gabriel. 44-45, *Sphaerium kendricki* n. sp. 44, Holotype. 45, Specimen from Lake Neerabub, W.A. 46, Paratype no. 23, juvenile shell with partially reversed hinge. 47, Lectotype of *Australpera cara* Cotton.



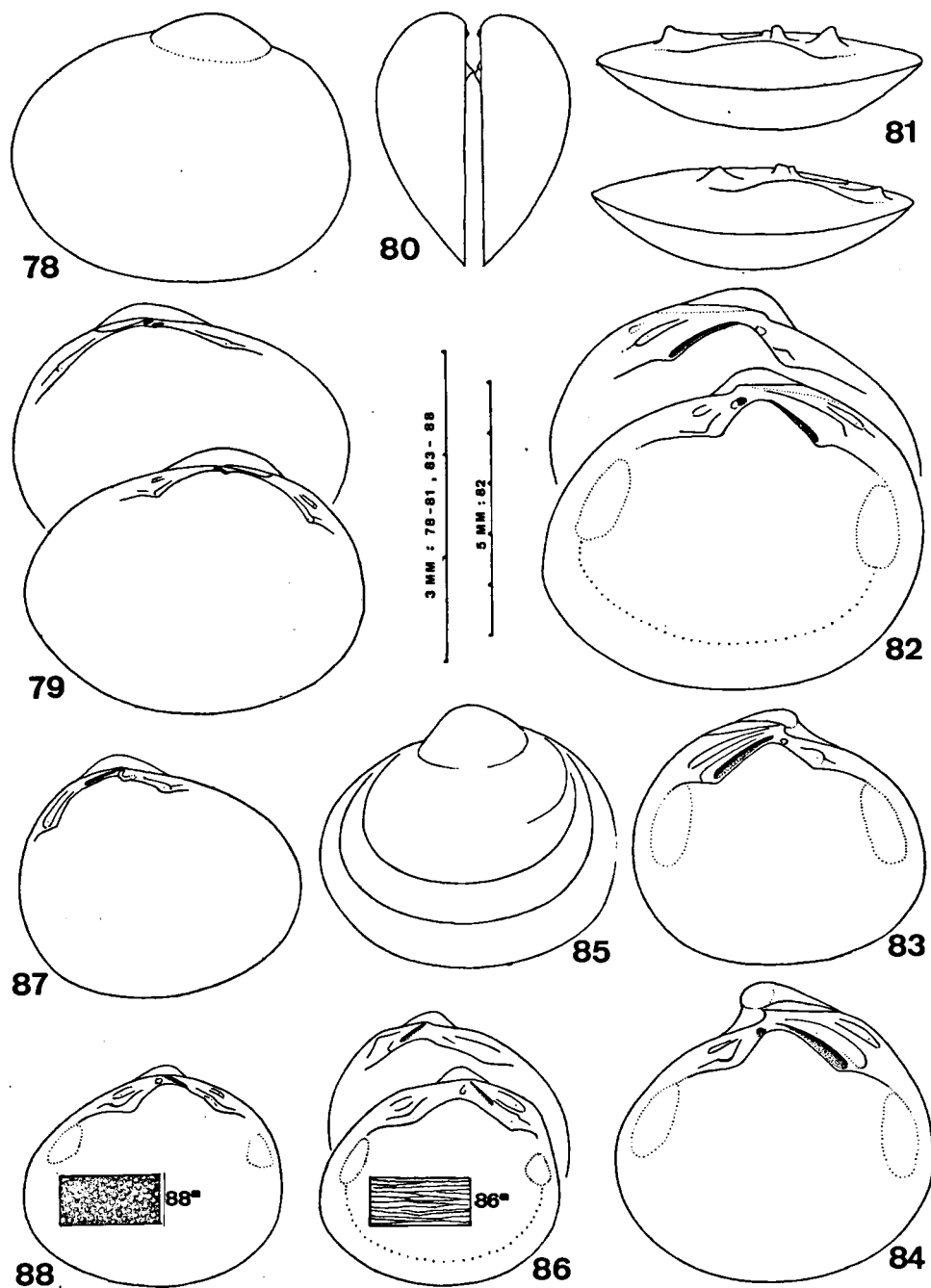
Figs. 48-53. Different forms of *P. casertanum* (Poli). 48, Armidale, N.S.W. 49, Lectotype of *Pisidium etheridgei* Smith. 50, Lagoon near Exeter, N.S.W. 51, Launceston, Tas. 52, Head of Ollera Creek, tributary of Gwydir R., New England, N.S.W. 53, Lectotype of *Australpera mena* Iredale.



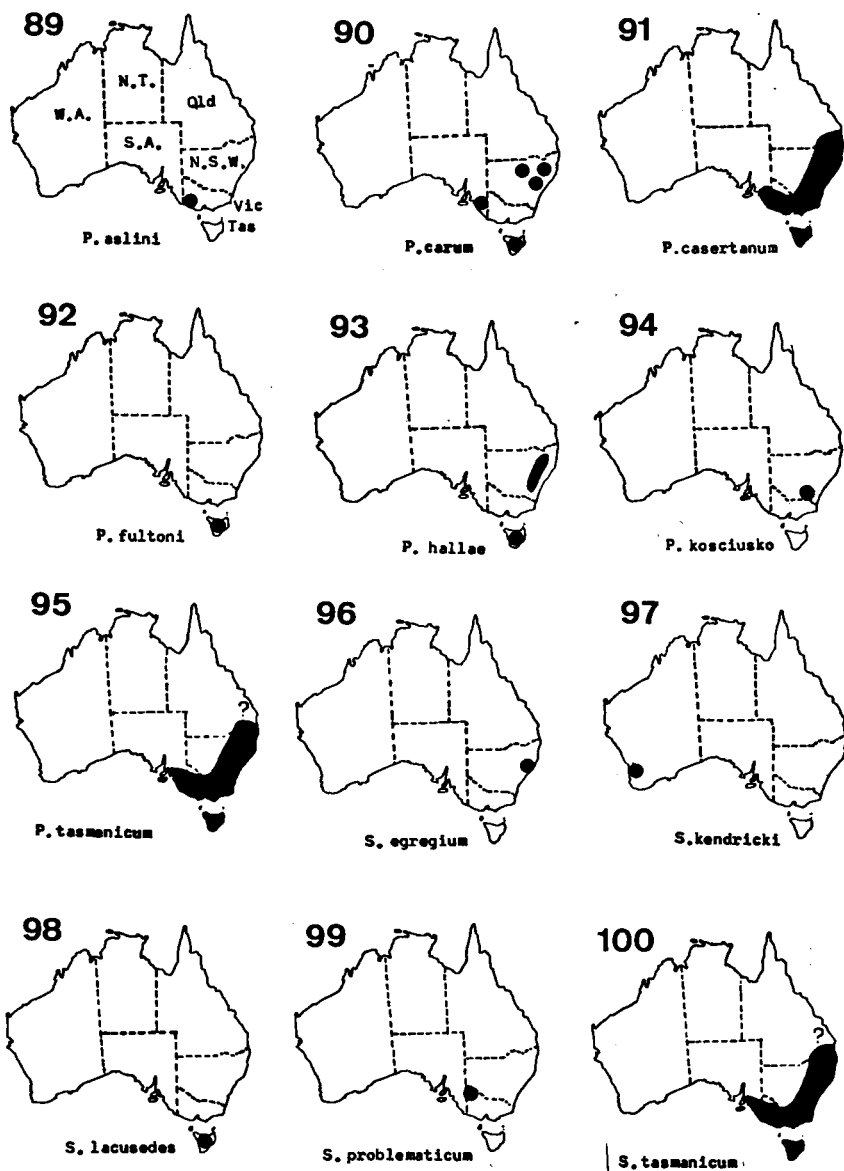
Figs. 54-64, Australian *Pisidium*. 54-57, *Pisidium carum* (Cotton). 54, Launceston, Tas. 55-57, Darling R., N.S.W. 58-64, *Pisidium tasmanicum* T.W. from different localities. 58, Launceston, Tas. 59 and 60, Umaralla R., R. of Numeralla, N.S.W. 61, Eagle Ck., Gordon R., Tas. 62, same specimen as fig. 58. 63 and 64, Lake Edgar, Tas.



Figs. 65-77, Australian *Pisidium*. 65-69, *Pisidium aslini* n. sp. 65, Hinge, ventral view, right valve on top. 66, Dorsal view. 67, Holotype, left valve; Lg, protruding ligament. 68, Hinge, right valve on top. 69, Profile view. 70-73, *Pisidium kosciusko* Iredale. 70, Holotype, interior. 71, Holotype, outside left valve. 72, Young shell, length 2.35 mm. 73, Young shell, length 1.55 mm. 74-77, *Pisidium fultoni* n. sp., Arthur's Lake, Tas. 74, Profile view. 75, Interior of paratype. 76, Specimen with long dorsal margin; posterior adductor impression below the horizontal median plan. 77, Interior view of specimen with long C3.



Figs. 78-88. Australian *Pisidium* and Leptonidae. 78-81, *Pisidium hallae* n. sp., paratype. 78, Outside left valve. 79, Interior, left valve on top. 80, Profile view, left valve at the left. 81, Dorsal view of hinge; left valve on top. 82, *Cyclas australis* Lamarck, largest specimen (L 8 mm) from Timor. 83-85, *Lasaea australis* (Lamarck) from type-locality "Port du Roi Georges". 83, Paratype no. 2. 84, Lectotype, right valve, specimen no. 1. 85, Paratype no. 7, left valve, outside. 86, *"Pisidium" semen* Menke, lectotype, left valve on top. 86a, pattern of microsculpture. 87, *Arthritica helmsi* (Hedley), from Portland, Vic., near Bridge at Nelson, leg. ASL. 88, Right valve. 88a, Pattern of microsculpture.



Figs. 89-100. Distribution of Sphaeriidae in Australia. 89-95, Genus *Pisidium*. 96-100, Genus *Sphaerium*. Abbreviations: W.A., Western Australia; N.T., Northern Territory; Qld, Queensland; S.A., South Australia; N.S.W., New South Wales; Vic, Victoria; Tas, Tasmania.