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TIJDSCHRIFT VAN DE NEDERLANDSE MALACOLOGISCHE VERENIGING

The Mollusc Fauna of Glasshouses in the Netherlands

by

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I. Introduction

Many publications seem to be written for no purpose at all, descending unexpectedly on a more or less surprised scientist who takes notice of the facts, wondering just what to do with his newly acquired knowledge. The origin of the researches laid down in this paper is easily retraceable to the inspiring publications of Baas Becking[1]), who has pointed out the truth in the words of Beijerinck, that, if we limit our attention to the study of micro-organisms, „everything is everywhere".

The authors of this publication hold the firm belief that if we keep an eye on the perpetual though not always praiseworthy activities of mankind, micro-organisms as well as higher organised beings may arrive at some time or another at every possible place on earth by means of ships, caravans, motor cars, railway carriages, aircraft or any other form of traffic, if only given time. The establishment of a certain organism at the place of arrival furthermore only depends on the presence of a suitable milieu for the development and propagation of the given species in that particular place.

As a starting point for our researches we chose the „man-made" or artificial milieus created all over the globe in glasshouses. We limited ourselves to the study of molluscs as these rather unpopular beings happen to be the „pet animals" of both authors and we had, judging from the literature, good reasons to expect interesting results.

In 1937 the senior author (Hubert), at the time at Ghent in Belgium, discovered in his aquarium a number of specimens of a peculiar Lymnaeid, which was quite unknown to him. The snails had most probably been introduced with aquatic plants from the Botanical Garden at Ghent. After some vain attempts to find the correct name of this apparently exotic species, he was forced to leave the matter undecided for the time being. In 1940, after his return to Holland, he discovered another exotic mollusc, a Planorbid this time, in water basins of the Victoria house of the Hortus Botanicus at Leiden. These discoveries

[1]) See e.g. „Geobiologie". W. P. van Stockum, The Hague, 1934.

aroused his interest in the mollusc fauna of glasshouses, which, as appeared from a study of the literature, in most cases contains a number of introduced species. In co-operation with the junior author, who had also collected several non-indigenous molluscs in tropical houses at Leiden and Delft, it was decided to make a thorough study of the whole mollusc fauna of the Dutch glasshouses. As we were naturally unable to investigate all the existing glasshouses in our country, particularly those used to grow crops for commercial purposes, we at first reduced the scope of this plan by exploring the hothouses mentioned below. We chose these localities because our collaborators had more or less easy access to them and because they possess the highest temperatures, so that they show the characters of the artificial milieu in the extreme. In addition, as many data as possible were gathered from various other sources. At our request, several colleagues collected material in a number of localities. We wish to thank them here for their kind assistance.

As we expected from the beginning, several tropical and subtropical molluscs have settled permanently in our hothouses, thus proving the truth that only the presence of a suitable milieu is necessary to give rise to a totally new fauna, mankind providing the means to reach these suitable places.

We hope and expect that many of our colleagues and collaborators who assisted us in collecting the molluscs dealt with in the following pages, or who chose other groups of animals and plants for further investigation of the composition of these remarkable habitats, will publish the result of their work too.

In our opinion it is highly desirable that in the not too distant future, a comprehensive work will be published, giving a compilation of the adventitious organisms which have arrived in our country during the last hundred years, including as many details as possible as to time, place and method of introduction. This compilation, together with the necessary data mentioned above, may aid scientists and naturalists in centuries to come to understand the origin and composition of the faunae and florae, which are, as we already pointed out, highly susceptible to modification due to the incessant activities of mankind. The large amount of evidence is growing almost daily and unless they are properly recorded, many interesting and important details of date and place of importation may be lost for ever.

It has been pointed out elsewhere (Meeuse, 1943) that most of the organisms forming a part of the „wild" (introduced) greenhouse fauna or flora, have a wide distribution, so that the introduced fauna and flora show a marked tendency to become uniform in composition. This apparently has to be ascribed to the more or less uniform ecological conditions prevailing in glasshouses all over the world (Cf. Miles and

Miles, 1935). It is to be expected therefore, that a species occurring in abundance in a particular hothouse is likely to appear at any moment in other places. This must often have occurred with glasshouse organisms, but only a few cases of migration could actually be traced step by step, Physa acuta (cf. Büttner, 1922) and Pseudosuccinea peregrina (cf. Boettger, 1929) being excellent examples. It is clear for this reason that unless the earliest date of appearance of every novel introduction is recorded as accurately as possible, the study of its subsequent gradual migration is impossible. We therefore searched the literature to collect as many such data as we could find. A few additional cases of such apparently recent introduction were discovered in the course of our investigation.

We hope that apart from the compilation mentioned above, another account of the glasshouse mollusca can be given in about 10 years, so that migrations of species (manifesting themselves as an increase in the number of localities) and eventually, entirely new introductions can be detected.

The literature on the subject will first be reviewed in brief. Secondly, an alphabetical list of the various species will be given. A detailed discussion of the species is to be found in the next part of this paper, which is an enumeration in which they are arranged according to Thiele's system. Finally, some general aspects of the glasshouse fauna will be surveyed.

2. Review of the literature

Most papers dealing with the occurrence of molluscs in glasshouses are scattered in the literature. Probably the first record of this kind was given by Miller (1822, p. 381) who described the occurrence of an exotic snail („Helix Goodalliii Miller", now known as Opeas pumilum (Pfr.)) in a Bristol greenhouse as early as 1816. Up to now, similar reports, mostly dealing with a single species, continue to appear in the literature and are, as such, usually not easily traceable. Fortunately an almost complete account of the literature up to 1928 has been compiled by Schlesch (1928a).

More or less complete studies of the mollusc fauna of hothouses in a certain area have been made in the Jardin des Plantes, Paris, by Dautzenberg (see Bouvier c.s., 1896, Dollfus c.s., 1896), in the Kew Gardens near London (see Thiselton-Dyer c.s., 1906), in Ireland (Stelfox, 1911), in Germany and Italy (Boettger, 1929a, 1930a, 1932), in Poland (Moszynski and Urbanski, 1932) and at Bern, Switzerland (Holzapfel, 1932). Altogether little has thus far been achieved in this field of science and much has still to be done.

3. Alphabetical list of the species so far known from Dutch hothouses

Altogether 41 species were collected. New records for the Dutch fauna are marked with an asterisk. Entirely novel additions to the fauna of glasshouses are marked with a § (indigenous species not included). The species which were apparently introduced as empty shells and never actually lived in the greenhouses in which they were found are not included, such as **Lithoglyphus naticoides** (Pfr.), **Valvata piscinalis** (O. F. Müll.), **Theodoxus fluviatilis** (L.). **Viviparus lacustris** Beck (= **V. viviparus** auct. germ., non Linné) or even the marine species **Spisula solida** (Da C.) and **Natica** spec..

1.	**Ancyclus lacustris** (L.)	(Pulmonata-Basommatophora, Ancylidae)
2.	**Arion hortensis** Fér.	(Pulm.-Stylommatophora, Arionidae)
3.	**Bithynia tentaculata** (L.)	(Prosobranchia, Hydrobiidae)
4.	**Carychium minimum** O. F. Müll.	(Pulm.-Stylomm., Ellobiidae)
5.	**Cecilioides acicula** (O. F. Müll.)	(Pulm.-Stylomm., Ferussaciidae)
6.	**Cochlicopa lubrica** (O. F. Müll.)	(Pulm.-Stylomm., Cochlicopidae)
7.	**Deroceras laeve** (O. F. Müll.) s.l.	(Pulm.-Stylomm., Limacidae)
8.	„ **reticulatum** (O. F. Müll.)	(Pulm.-Stylomm., Limacidae)
9.	**Galba palustris** (O. F. Müll.)	(Pulm.-Basomm., Lymnaeidae)
10.	**Gonyodiscus rotundatus** (O. F. Müll.)	(Pulm.-Stylomm., Endodontidae)
*11.	**Hawaiia minuscula** (Binn.)	(Pulm.-Stylomm., Zonitidae)
*12.	**Helicodiscus parallelus** (Say)	(Pulm.-Stylomm., Endodontidae)
*§13.	**Helisoma nigricans** (Spix) (= **H. tenagophilum** (D'Orb.))	(Pulm.-Basomm., Planorbidae)
14.	**Helix aspersa** O. F. Müll.	(Pulm.-Stylomm., Helicidae)
*§15.	**Isidora proteus** (Sow.)	(Pulm.-Basomm., Planorbidae)
16.	**Limax flavus** L.	(Pulm.-Stylomm., Limacidae)
17.	„ **maximus** L.	(Pulm.-Stylomm., Limacidae)
18.	**Lymnaea stagnalis** (L.)	(Pulm.-Basomm., Lymnaeidae)
*19.	**Opeas mauritianum** (Pfr.)	(Pulm.-Stylomm., Subulinidae)
20.	„ **pumilum** (Pfr.)	(Pulm.-Stylomm., Subulinidae)
21.	**Oxychilus alliarius** (Miller)	(Pulm.-Stylomm., Zonitidae)
22.	„ **cellarius** (O. F. Müll.)	(Pulm.-Stylomm., Zonitidae)
23.	„ **draparnaldi** (Beck)	(Pulm.-Stylomm., Zonitidae)
24.	**Physa acuta** Drap.	(Pulm.-Basomm., Physidae)
25.	**Physa fontinalis** (L.)	(Pulm.-Basomm., Physidae)
26.	**Planorbarius corneus** (L.)	(Pulm.-Basomm., Planorbidae)
27.	**Planorbis planorbis** (L.)	(Pulm.-Basomm., Planorbidae)
*28.	**Pseudosuccinea columella** (Say) (= **Ps. peregrina** (Cless.))	(Pulm.-Basomm., Lymnaeidae)
29.	**Radix auricularia** (L.)	(Pulm.-Basomm., Lymnaeidae)
*§30.	„ **javanica longula** (Mouss.)	(Pulm.-Basomm., Lymnaeidae)
31.	„ **ovata** (Drap.)	(Pulm.-Basomm., Lymnaeidae)
32.	**Retinella hammonis** (Ström) (= **R. radiatula** (Alder))	(Pulm.-Stylomm., Zonitidae)

33. Sphaerium lacustre (O. F. Müll.) (Lamellibranchia, Sphaeriidae)
34. Spiralina vortex (L.) (Pulm.-Basomm., Planorbidae)
*35. Testacella europaea Roissy (= T. haliotidea Drap.) (Pulm.-Basomm., Testacellidae)
*§36. Thiara tuberculata (O. F. Müll.) (Prosobranchia, Thiaridae = Melaniidae)
37. Trichia hispida (O. F. Müll.) (Pulm.-Stylomm., Helicidae)
38. Vallonia costata (O. F. Müll.) (Pulm.-Stylomm., Valloniidae)
39. „ pulchella (O. F. Müll.) (Pulm.-Stylomm., Valloniidae)
*§40. Varicella clappi Pilsbry (Pulm.-Stylomm., Oleacinidae)
41. Zonitoides nitidus (O. F. Müll.) (Pulm.-Stylomm., Zonitidae)

Not taken into account are several exotic species which have been found in bananas, or otherwise introduced, and which were discovered when they arrived in our country even before they had a chance to establish themselves. We mention as examples Pleurodonte (Dendrocochlis) aspera (Brug.), which is often found in West-Indian bananas, and a specimen of Bulimulus auris-leporis Brug. introduced from Santos, Brazil, with orchids, and found in the Zoological Garden, Rotterdam, July 1939 (L. P. Pouderoyen, in litt.).

4. Discussion of the species, arranged according to the system of Thiele's „Handbuch der systematischen Weichtierkunde"

List of main localities:

Groningen, hothouses of Hortus Botanicus. Collector S. J. Geerts (1942).
Het Loo, near Apeldoorn, hothouses of the Royal Summer Residence. Collector B. J. D. Meeuse (1944).
Wageningen, hothouses belonging to the Arboretum. Collectors A. F. H. Besemer and A. D. J. Meeuse (1942, 1943).
Utrecht, hothouses of Hortus Botanicus. Collectors J. van Dalsum, R. A. Maas Geesteranus, A. D. J. Meeuse, S. J. van Ooststroom (1942).
Baarn, hothouses belonging to the „Cantonspark". Collectors J. van Dalsum (1942 and 1943), L. B. Holthuis, A. D. J. Meeuse, C. O van Regteren Altena (1949).
Amsterdam, hothouses of Hortus Botanicus. Collectors B. Hubert, F. E. Loosjes, A. D. J. Meeuse, S. J. van Ooststroom (1942, 1943), A. R. Schouten, Meeuse (1947/1949). Hothouses of Zoological Gardens (Artis), Schouten 1947/1948.
Lisse, greenhouses of the Laboratorium voor Bloembollenonderzoek. Collector A. D. J. Meeuse (1943).
Leiden, hothouses of Hortus Botanicus. Collectors L. B. Holthuis, B. Hubert, A. D. J. Meeuse, S. J. van Ooststroom, C. O. van Regteren Altena, W. Vervoort (1942 to 1948, and earlier).
The Hague ('s-Gravenhage), hothouses of the „Koninklijk Zoölogisch Genootschap" (Zoological Garden). Collectors B. Hubert, A. D. J. Meeuse (1942). Hothouses destroyed in 1944 during German occupation.
Delft, hothouses of the „Cultuurtuin voor Technische Gewassen". Collectors A. D. J. Meeuse, B. J. D. Meeuse (1942 to 1949, and earlier).

Naaldwijk, greenhouses of the „Proeftuin Glasdistrict Naaldwijk". Collectors A. D. J. Meeuse, J. de Wilde (1944).
Rotterdam, hothouses of the new Zoological Garden (Diergaarde „Blijdorp"). Collectors L. P. Pouderoyen, Dr. W. H. Wachter (1942, 1943).

N.B. These localities are mentioned in the text merely as „Groningen", „Het Loo", „Wageningen" etc. The localities in Amsterdam are indicated by: „Amsterdam-H. B." and „Amsterdam-Art." Other localities, collectors or collecting dates are mentioned fully.

The material collected during the investigation is mainly in our private collection, but all important species are amply represented by duplicates from nearly all localities in the Rijksmuseum van Natuurlijke Historie (Leiden) and in the Zoological Museum, Amsterdam. Specimens studied belonging to other collections will be especially mentioned in the text

We wish to thank Mrs. W. S. S. van der Feen née Van Benthem Jutting (Amsterdam), Dr. H. Schlesch (Copenhagen), Dr. Ch. Bayer (Leiden) and Dr C. O. van Regteren Altena (Leiden) for their assistance in naming several of the species, and Dr J. Th. Henrard (Leiden) for the use we were allowed to make of his rich collections.

GASTROPODA

Thiara (Melanoides) tuberculata (O. F. Müll.). Plate I fig. 6
Synonym: **Melania tuberculata** (O. F. Müll.)
Literature: Kristensen, 1942.
Localities: Leiden, in aquaria (Meeuse, 1942), a few specimens. Not collected, but a specimen was photographed (see fig. I) in living state and put back in the aquarium afterwards.
Utrecht, in water basin, rather abundant (1942, found by several collectors.).
Distribution: From Malta and Africa to North Australia.
Remarks: The hothouse specimens are undoubtedly descendants of four specimens imported with tropical fishes (probably from Sumatra, see Kristensen, 1942) in 1933. The original specimens were only discovered after their arrival at Utrecht, because they had been hidden in the sand covering the bottom of the aquarium which had been used to transport the fish. They propagated so well that in a few years the offspring amounted to several hundreds of individuals. The species was introduced in Leiden by Kristensen in 1938. A few years later he left Leiden and many of his tropical fish were transferred to the aquaria of the Leiden Botanical Garden. Obviously some of his snails were imported together with the fish, so that Thiara was discovered soon afterwards as an introduced hothouse species. Its occurrence in the Hortus Botanicus at Utrecht was apparently brought about in the same way, viz. by importation with fish or water plants. Thiara usually hides in the muddy layer covering the bottom of the water basins or in the sand of the aquarium in which it occurs. It propagates so quickly on account of its viviparity,

that it appears that it will spread rapidly over our hothouses (cf Addendum no. 1, p. 30). So far this is the first record of the species outside its natural area of distribution.

Bithynia tentaculata (L.)

Literature: Van Benthem Jutting 1933, p. 87—89; Schlesch, 1928a.
Localities: Groningen, in water basins.
Utrecht, water basin.
Leiden, in water basins, 1940-1944.
The Hague, water basins, July 1923, leg. Hubert (specimens in coll. Pouderoyen, Rotterdam); again collected in 1942.
Distribution: Europe, Asia Minor, Siberia, N. Africa; introduced in N. America (Great Lake area).
Remarks: Not previously recorded from the greenhouses, but apparently not an incidental introduction, since it has lived in the hothouses of the Zoological Garden in The Hague for at least 19 years. The species occurs in considerable numbers in all the above localities and seems to feel quite at home under glasshouse conditions. Bithynia tentaculata is by no means rare in our country, where it is found on the bottom of almost every ditch, pond and canal, so that introduction into hothouses with water weeds or with mud (used as bottom layer in the water-lily tanks), is likely to occur.

Carychium minimum O. F. Müll.

Literature: Van Benthem Jutting, 1933. p. 156.
Locality: Amsterdam-Art., 1 spec., leg. Schouten, in tropical house, 19 III 1948.
Distribution: Palaearctic.
Remarks: This snail is very common in moist places and is likely to be introduced into hothouses. It has been reported before from several other hothouses in Europe.

Physa fontinalis (L.)

Literature: Van Benthem Jutting, 1933, p. 187.
Locality: Amsterdam-H.B., leg. A. R. Schouten.
Distribution: Palaearctic.

Physa acuta Drap. Plate III, fig. 13, 14

Literature: Van Benthem Jutting, 1933, p. 185—187; Van Heurn, 1911; Scholten, 1913a and b; Büttner, 1922 (a survey of the older literature); Boettger, 1929a; Holzapfel, 1932; Urbanski, 1933; Meeuse, 1948.
Localities: Groningen, water basins.
Utrecht, leg. M. A. Donk, 1926 (in coll. Henrard), in 1942 and 1943 still living there and found by various collectors.
Amsterdam, Hortus Botanicus, about 1912 (see Scholten, 1913); in 1926 re-collected by W. J. Lütjeharms (coll. Henrard); in 1942 still abundant there.

Leiden, Hortus Botanicus, about 1909 (see Van Heurn, 1911); often collected again from 1924 onward (various collectors).
The Hague.
Delft, 1937, leg. Meeuse (in coll. Henrard); 1942—1949.
Rotterdam.

Distribution: North Africa and Southern Europe northwards to Alsace-Lorraine and Belgium. Introduced and run wild elsewhere in Europe (England, Germany, Poland, Russia, see e.g. Büttner, 1922).

Remarks: The first record of this species in glass-houses dates from 1860, when it was found in a „lily-tank" in the Kew Gardens, England. It has been found as an introduction in many places since (Paris, Germany, Poland, Switzerland) and eventually run wild, a process which was certainly facilitated by the fact that some 40 years ago the species was often cultivated in aquaria. It first made its appearance in the Netherlands in the former Victoria house at Leiden about 1909. It was found in a canal near Leiden only a few years later, apparently as an escape from the hothouse mentioned. In 1912 it was collected in a greenhouse of the Hortus Botanicus, Amsterdam, and again appeared in the neighbourhood in the open soon afterwards. Physa acuta seems to be extremely well adapted to a life in a greenhouse. It is now found in our country in every hothouse in which water basins of any importance are present. It may be safely assumed that this species has spread over all the European hothouses and has become one of their permanent inhabitants.

Albinotic specimens of Physa acuta were collected by J. Th. Henrard at Leiden in the former Victoria house in 1926 (in coll. Henrard), but no more specimens have since been observed.

Though several other Physidae have been reported from European hothouses, we are satisfied that all our specimens belong to Physa acuta Drap. The other species recorded are: Physa gabbi Tryon, Ph. gyrina Say (see Stelfox, 1911, and Ellis, p. 116—118), Ph. heterostropha Say (see Boettger, 1929a) and Ph. ancillaria Say (Boettger, 1930b), all of them North American species. In our opinion, at least part of these records must be considered with some doubt, because, as Stelfox remarks (op. cit., p. 135): „in a group like that of the Physidae, it is practically impossible to give an imported species a name, unless one has some idea as to the origin of the specimens." We received Ph. heterostropha from the hothouses at Berlin-Dahlem (Berlin) leg. Th. Schmierer and from Danmarks Akvarium (Copenhagen) leg. Mandahl-Barth. Specimens of a Physa closely resembling Ph. heterostropha Say have been collected in our country already, but they were taken in a ditch in the open at Rijswijk near The Hague and not in a glasshouse (M. A. Donk leg., July 1925, specimens in coll. Henrard). They closely resemble

specimens of the species from Tampico, Mexico (leg. Kuiper). The locality at Rijswijk has since been destroyed and Ph. heterostropha has disappeared (cf. Henrard & Meeuse, 1942, p. 120—121).

Lymnaea stagnalis (L.)

Literature: Van Benthem Jutting, 1933, p. 193—196.
Localities: Groningen, Utrecht, Leiden, Delft.
Distribution: Holarctic.

Remarks: A common indigenous aquatic species and likely to be introduced (compare **Bithynia tentaculata** on p. 7). The specimens are mostly juvenile and never occur in large numbers, so that it seems doubtful if the species will ever settle permanently. Apparently not previously recorded from glasshouses.

Galba palustris (O. F. Müll.)

Literature: Van Benthem Jutting, 1933, p. 200—201.
Localities: Utrecht.
Leiden, Hortus Botanicus 1926 (coll. Henrard), but since disappeared.
Distribution: Holarctic.

Remarks: A common indigenous species, likely to be occasionally introduced, but probably unable to live permanently under hothouse conditions.

Radix auricularia (L.)

Literature: Van Benthem Jutting, 1933, p. 196—197; Baker, 1901; Schlesch, 1927; Boettger, 1929a, 1930a.
Localities: Leiden.
The Hague, Zoological Garden, June 1923 (leg. Hubert, specimens in coll. Pouderoyen, Rotterdam).
Distribution: Europe, Northern Asia, introduced in several places in the U.S.A. in the open as well as in hothouses.

Remarks: Reported several times from hothouses in Europe and in the U.S.A. According to Boettger, the species is often cultivated by Berlin naturalists in tropical aquaria and seems quite at home under these conditions.

Radix javanica longula (Mouss.) Plate I fig. 1a, b, 2

Literature: Mousson, 1849, p. 43, pl. V fig. 2 (Lymnaea longula); Hubert & Meeuse, 1943, p. 124.
Locality: Rotterdam.
Distribution: Sumatra, Java, Lesser Sunda Islands.

Remarks: This very interesting Lymnaeid was discovered in August, 1942, by Dr. W. H. Wachter in the hothouse of the „Diergaarde Blijdorp", where it lives in considerable numbers in shallow basins, which almost completely dry up from time to time. It was sent to Miss Van Benthem Jutting for identification, who recognised

it as R. javanica longula. It is remarkable that all our specimens belong to the form longula, though Radix javanica is known to be extremely variable. Our biggest specimen measures 18 × 7 mm, but for the most part the specimens are much smaller, about half that size. We do not know in which way this snail has been introduced in the hothouse at Rotterdam, but it would seem as if it were brought there, probably unintentionally, with imported fish or water plants from the Dutch East Indies. This must have happened before May 1940, when the communication with our colonies was disrupted. This implies that R. javanica longula must have been living in the old Zoological Gardens at Rotterdam and was transferred together with the live stock of plants and animals to the new buildings at Blijdorp, because this transfer took place after the date mentioned.

Radix ovata (Drap.)

Literature: Van Benthem Jutting, 1933, p. 198—200.
Localities: Groningen, Het Loo, Utrecht, Baarn, Leiden, Delft, Naaldwijk.
Distribution: Europe, Northern Asia.
Remarks: This very common indigenous species apparently has not been previously recorded from hothouses. The specimens we have seen were scarce and mostly juvenile, so that it is likely that the occurrence of the species in hothouses is only transitory.

Pseudosuccinea columella (Say) Plate I fig. 3, 4, 5

Synonym: Pseudosuccinea peregrina (Clessin)
Literature: Say, 1817, p. 14 (Lymnaea columella); Clessin, 1882, p. 188—189 (Limnaea peregrina); Schlesch, 1928b, 1930a, and b; Boettger, 1929a; Urbanski, 1933; Henrard & Meeuse, 1942, p. 120—121.
Localities: Wageningen, Utrecht, Amsterdam H.B. (1940—1949, 1940 leg. G. Monnickendam, in Mus. Amsterdam), Leiden (1940—1948), Lisse, The Hague, Delft (1937, leg. Meeuse, in coll. Henrard; id. leg. H. Odé, in coll. Odé; also 1942-1949); Rotterdam, Baarn (1949).
Distribution: North America (Ps. columella), Brazil, Bolivia and Paraguay (Ps. peregrina). Introduced in hothouses in Europe.
Remarks: Pseudosuccinaea columella was discovered in Europe for the first time by Schlesch in 1927 in the hothouses of the Botanical Garden, Copenhagen. Soon afterward it was reported from the hothouses in Göttingen (1928, see Schlesch, op. cit.), Berlin and various other places in Germany, and from Poland.

In 1937 it was collected at Delft, but it was not recognised until 1942 when we sent a few specimens to Dr. Schlesch, who named them for us and confirmed our own determination (as Ps. peregrina). In the same year (1937) it had been collected by Hubert at Ghent, Belgium. By courtesy of Dr. Schlesch we received specimens from various other localities, some of them as yet unpublished: Copen-

hagen, Botanical Garden, leg. Schlesch, 1928; Göttingen, Botanical Garden, leg. Schlesch, 1929; Warsaw (Poland), hothouse in Park Larienski, leg. A. Jankowski, 26-IX-1936.

Our specimens exactly resemble the specimens mentioned and the „wild" specimens collected in Paraguay, Arojo Tacuara, Colonia Independencia, leg. F. H. Schade 1932 (e coll. Schlesch) and specimens from Berlin-Dahlem, Botanical Garden, leg. Th. Schmierer, 1939. Mr. Mandahl-Barth kindly sent us specimens from Danmarks Akvarium, Copenhagen, sub nomine **Ps. columella**. We had already noticed the resemblance between the specimens named **Ps. peregrina** (from European hothouses and from South America) and those named **Ps. columella** (North America). These two described species are so very much alike, that the junior author studied as many specimens of the genus **Pseudosuccinea** as possible. Apart from the specimens mentioned, he studied specimens of both species at the Natural History Museum, South Kensington, London, and the Rijksmuseum van Natuurlijke Historie, Leiden, and specimens from a number of localities in the U.S.A. kindly sent by Dr. H. van der Schalie (Ann Arbor, Mich.). It appeared that the considerable number of „wild" specimens dealt with (about 200) show the same variation in the size, shape, striation and colour of the shell as the hothouse specimens of which some 500 specimens were examined, so that the two described species show the same variation in the characters of the shell and it is impossible to distinguish the one from the other judging by the shells only. As long as it has not been proved that there are anatomical differences, we consider these two species to be identical. The only objection that might be raised is that they are geographically separated, **columella** occurring in North America and **peregrina** in South America, but Dr. Van der Schalie informed us that he collected **Ps. columella** in Puerto Rico, so that the area of distribution may well be continuous and the species may possibly occur in Central America as well.

Pseudosuccinea has spread very rapidly over Europe in hothouses, as the following record shows: 1927 Copenhagen, 1928 Göttingen, Berlin, 1932 Poznan (introduced after 1930!), 1936 Warsaw, 1937 Ghent and Delft, 1940 Leiden and Amsterdam, in 1942—1944 of common occurrence in practically all hothouses with water basins in Holland. In 1948 collected in the houses of the Botanical Gardens, Edinburgh (Meeuse).

In our country **Ps. columella** is apparently of recent introduction. It is practically certain that it has been introduced into the Leiden hothouses after 1938, for the mollusc fauna was thoroughly investigated in that year by J. Th. Henrard, S. J. van Ooststroom

and A. D. J. Meeuse, before the old Victoria house was pulled down. Physa acuta appeared to be the only exotic aquatic mollusc at that time.

Pseudosuccinea is so well adapted to hothouse conditions, that it settles down very soon in all places of introduction. In most places it already occurs in large numbers. We estimate that in the summer months of 1942 at one time hundreds of specimens were present in the new Victoria house at Leiden.

It is certain that Ps. columella was introduced at Blijdorp (Rotterdam) with water plants from the hothouse at Leiden, because they first appeared only in aquaria which had been provided with the imported plants from Leiden (cf. Addendum 2, p. 30).

Pseudosuccinea columella is characterised by the peculiar structure of its shell consisting of fine spiral and more or less zigzagging transverse striae forming a fine pattern (cf. Plate I, fig. 5).

The genus Pseudosuccinea undoubtedly derives its name from its resemblance to Succinea, which similarity is still more emphasized by the peculair habit of these pulmonate molluscs of leaving the water and crawling along the leaves and stems of aquatic plants above water level. At first it was suggested by us that this remarkable behaviour is only shown in the hothouse with a high relative humidity, but this assumption did not hold true as we observed that the animals did not alter their habit when brought into aquaria in a normal living-room. It was regularly observed by us that the animals, which had been placed in shallow open basins in our room for observation, had to be collected elsewhere in the room the following morning, often at rather great distances from the water basins. It should be kept in mind by prospective students of this interesting genus that their aquaria should be covered by glass plates!

Our largest specimens measure 17 × 8 mm.

Apart from the species mentioned the following exotic Lymnaeid has been reported from European hothouses:

Galba cubensis (Pfr.) — Berlin, see Boettger, 1929a, a native of the West-Indies. According to Boettger, the same species must have been collected by Stelfox in an Irish greenhouse.

Planorbis planorbis (L.)

Literature: Van Benthem Jutting, 1933, p. 171—172.

Locality: Utrecht (about six specimens altogether), Amsterdam-H.B. (Schouten).

Distribution: Europe, N. Africa, Levant, Siberia.

Remarks: Very common in stagnant waters, probably incidentally introduced. It remains to be seen whether this palaearctic species will ever settle down permanently in a tropical house.

Planorbarius corneus (L.)

Literature: Van Benthem Jutting, 1933, p. 168—170; Holzapfel, 1932.
Locality: Delft (B. J. D. Meeuse leg.), a single juvenile specimen.
Distribution: Europe, Asia Minor.

Remarks: This common aquatic snail was apparently introduced incidentally, though it has been reported from hothouses at Bern (Switzerland) by Holzapfel.

Helisoma (Taphius) nigricans (Spix) Plate II fig. 9, 10, 11, 12

Synonym: **Helisoma tenagophilum** (D'Orb.)
Literature: Spix & Wagner, 1827, Pl. XVIII fig. 3, 4, 5, 6 (**Planorbis nigricans** Spix), p. 27 (**Planorbis lugubris** Wagner, type locality: State of Bahia, Brazil); D'Orbigny, 1847, pl. XLIV fig. 9—12 (**Planorbis tenagophilus**); Lutz, 1927, p. 51—52, 71—72.
Localities: Groningen.
Utrecht 1938 (in 1942 disappeared, see below).
Baarn (1942, 1943, in 1949 disappeared), Lisse, Leiden, Delft, The Hague, Rotterdam.
Distribution: Brazil, Uruguay, Paraguay.

Remarks: This interesting species was collected in the Victoria house of the Botanical Garden, Leiden, by Hubert in 1940, but later it appeared that Miss Bremekamp (now Mrs. Nannenga) had already specimens in her collection dated August, 1938, from the Botanical Garden, Utrecht. It was named for us by Dr. Schlesch, who also kindly sent us an authentical specimen from Villarrica, Paraguay, leg. F. A. Schade 1933 (det. F. Haas), which exactly resembles our specimens. For a detailed description of the species we refer to Lutz (1927). We also received specimens of **H. nigricans** from Magdeburg, Germany, Grusows Gewächshäuser, leg. K. Regius, 1941, and from Danmarks Akvarium (Copenhagen) leg. G. Mandahl-Barth, VIII-1943. These localities have not been recorded before.

Dr. Koumans (Leiden) sent us several specimens of this snail and informed us that he had had the species in cultivation in his aquarium for some ten years (i.e. since 1933). The animals were introduced unintentionally with aquatic plants bought from a dealer. When we investigated this point it appeared that at present the species under discussion is to be found in many tropical aquaria, but the owners usually mistake it for the common **Planorbarius corneus**. We may safely assume that **Helisoma nigricans** was also introduced into our hothouses with aquatic plants, and it would seem as if it were originally imported from its native country into Europe in the same way. **H. nigricans** usually occurs in large numbers, but the specimens are mostly small, probably because they grow slowly and die or are ex-

terminated before reaching their ultimate size. Our finest specimens measure 19 × 16 × 6½ mm. According to Lutz the species may ultimately attain a size of 22—23 mm × 8—9 mm.

We noticed two different forms, one with dark olive animal and the other with red animal. The shells show hardly any difference, that of the form with red animal is somewhat paler corneous brown. The latter form apparently lacks the body-pigment, a phenomenon not uncommon in Planorbidae (cf. Boettger, 1933).

The most remarkable feature of the animals when observed in an aquarium is the possession of very long tentacles, which apart from other differences may serve to distinguish between this species and **Planorbarius corneus**. It is furthermore not to be expected that **H. nigricans** will establish itself in the open waters in our country, as we observed that when kept in an aquarium at room temperature, their shells become corroded, growth practically ceases and the animals die successively.

The related **Helisoma tumidum** (Pfr.), a native of the West Indies, has been found in the Victoria regia house of the Botanical Garden, Berlin-Dahlem (Boettger, 1929a). A third species belonging to this American genus, viz. **H. trivolve** (Say) from North America, was collected in an aquarium in the Botanical Gardens, Moscow, leg. Arvid Nilsson, 1936 (in coll. Schlesch, Schlesch, priv. comm.). Quite recently (1948) Mr. H. K. Airy-Shaw and Mr. B. Verdcourt collected a fourth **Helisoma** at Kew Gardens. According to Pilsbry who named the specimens, the material contained two species, viz. **H. duryi** Wetherby and **H. eudiscus** Pilsbry. H. B. Baker, however, considers these varieties of one species, which seems to be more likely as the two forms occurred at Kew in the same aquarium.

Spiralina vortex (L.)

Literature: Van Benthem Jutting, 1933, p. 173—175.
Locality: Delft.
Distribution: Europe, Siberia.
Remarks: Apparently an occasional introduction of this common indigenous species, because it was found in an aquarium with duck-weed (**Lemna** spec.), which had been collected in a ditch nearby.

Isidora proteus (Sow) Plate II fig. 7, 8

Locality: Delft, Cultuurtuin voor Technische Gewassen, hothouses, leg. Meeuse, 1937 (in coll. Henrard); also collected 1942—1944.
Distribution: South Australia.
Remarks: A reddish form of this species was imported into Germany from Adelaide in 1926 for commercial purposes (cultivation in aqua-

PLATE I

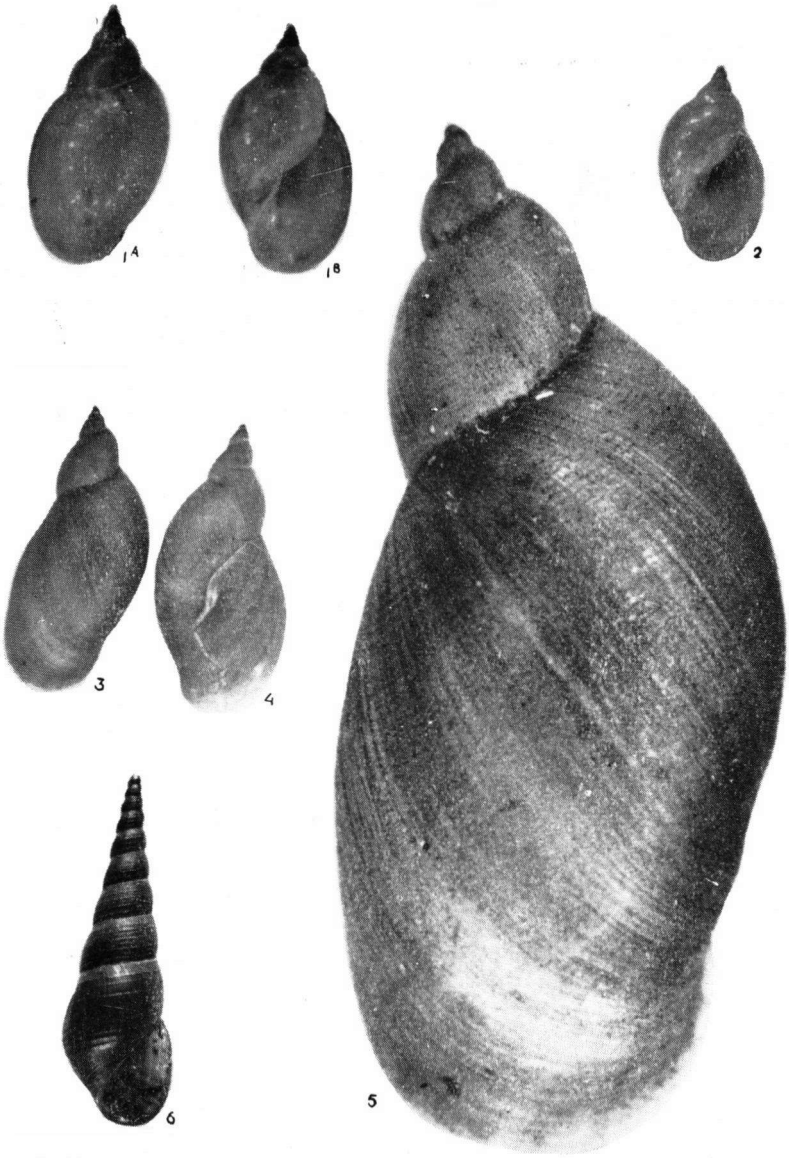

Fig. 1a, b. **Radix javanica longula** (M o u s s o n), adult specimen, from two sides, × 1½. Fig. 2 **Radix javanica longula** (M o u s s o n), juvenile specimen, × 1½. Fig. 3, 4. **Pseudosuccinea columella** (S a y), two adult shells, from Leiden, × 2. Fig. 5. **Pseudosuccinea columella** (S a y), × 8, to show shell structure. Fig. 6. **Thiara tuberculata** (O. F. M ü l l.), living specimen, from Leiden, × 1⅜. (All the photographs were taken in co-operation with Mr. D. t e r H a a r, Mr. M. v a n E c k, Dr. D. A. K r e g e r and Mr. N. v a n K u y e r e n, whom we wish to thank here for their kind assistance).

PLATE II

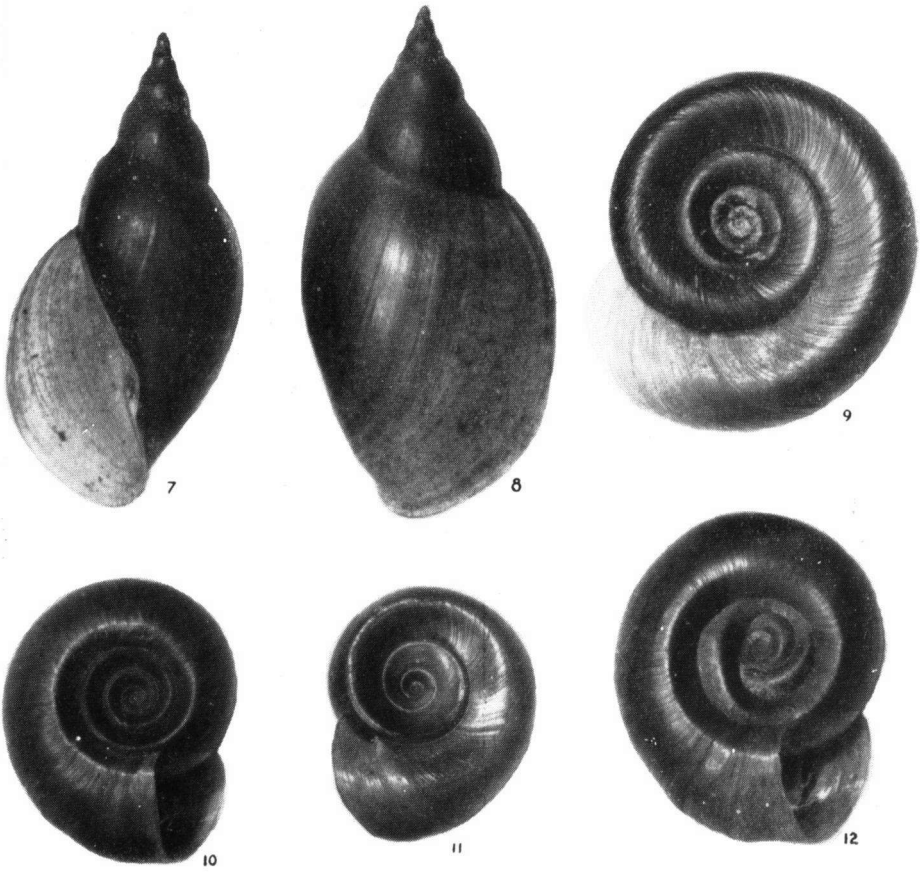

Fig. 7, 8. Isidora proteus (S o w e r b y), two specimens from Delft, × 4.
Fig. 9, 10, 11. Helisoma nigricans (S p i x), three shells from Leiden, × 2²/₃.
Fig. 12. Helisoma nigricans (S p i x), specimen from Leiden, with abnormal growth of the first whorls, × 2²/₃.

ria). A few years later it was also imported into Holland from Germany. At Delft it was cultivated some 15 years ago in the aquaria of the hothouses. It has since escaped from cultivation but does not seem to multiply noticeably. By way of experiment we have planted a few specimens of this species in one of the water basins of the Victoria house at Leiden, in order to see if Isidora proteus is capable of „running wild" in a hothouse.

I. proteus has been found as an escape in a Berlin park in the open (Boettger, 1937), but it could not stand the Central European winter and did not survive. The species has not been reported from greenhouses before.

Apart from the species mentioned, the following exotic Planorbidae have been found in European greenhouses:

Planorbina straminea (Dunk.), from S. America, in hothouses, Berlin-Dahlem (Boettger, 1929a, 1930b);

Tropicorbis orbiculus (Mor.) from Central America (same locality, Boettger op. cit.);

Planorbis adowensis Bgt. from the Abyssinian region, in aquaria of the Zoological Gardens (Tierpark Dählhölzli), Bern, see Bernoulli, 1943, p. 32;

Pierosoma tenuis (Philippi), sent to us by Mr. Mandahl-Barth, introduced in Danmarks Akvarium, Copenhagen, leg. VIII-1943, a native of North America, and

Gyraulus (Torquis) parvus (Say), Danmarks Akvarium, leg. Mandahl-Barth, VIII-1943, a native of North America.

The last two species were not recorded from hothouses before.

Ancylus lacustris (L.)

Literature: Van Benthem Jutting, 1933, p. 163—164.
Localities: Amsterdam, Leiden, Delft. (1942, 1943).
The Hague 1940 or 1941 (Hubert, not collected).
Distribution: Europe, N. Asia, N. Africa.
Remarks: This species is very common in our country and occurs by preference on the stems and leaves of aquatic plants, so that the possibility of its being introduced is always present. It seems to feel quite at home in a tropical house and sometimes occurs in considerable numbers. Apparently not previously reported from greenhouses.

Cochlicopa lubrica (O. F. Müll.)

Literature: Van Benthem Jutting, 1933, p. 209—210; Holzapfel, 1932; Boettger, 1929a.
Locality: Delft (five specimens).
Distribution: Holarctic.
Remarks: Common in our country and likely to be introduced from outside. Reported from greenhouses in Germany and Switzerland.

Vallonia pulchella (O. F. Müll.)

Literature: Van Benthem Jutting, 1933, p. 214—215; Schlesch, 1928a; Boettger, 1929a; Holzapfel, 1932; Moszynski and Urbanski, 1932.
Localities: Utrecht, Leiden, Rotterdam.
Distribution: Holarctic.
Remarks: Reported from greenhouses in Europe and in the U.S.A.

Vallonia costata (O. F. Müll.)

Literature: Van Benthem Jutting, 1933, p. 215—216.
Locality: Leiden.
Remarks: Not previously recorded from greenhouses, but very common in our country and living in exactly the same places as the preceding species, so that its introduction in greenhouses and its subsequent settling down was not unexpected.

Cecilioides acicula (O. F. Müll.)

Literature: Van Benthem Jutting, 1933, p. 293—294; Moszynski and Urbanski, 1932; Schlesch, 1942.
Locality: Utrecht.
Distribution: S.W. and Central Europe, in Northern Europe chiefly found in greenhouses.
Remarks: Cecilioides acicula is essentially a subterranean snail and needs much moisture, so that its occurrence in greenhouses with a high R.H. is not unexpected. It is interesting to note, that in the greenhouse at Utrecht, where the specimens were taken, they were observed creeping actively around on the surface (which consisted of moist gravel), though specimens living in the open are only found in a living condition at some distance below the surface of the soil.

Opeas pumilum (Pfr.) Plate III fig. 16, 17, 18

Synonym: O. goodallii (Mill.), see Kennard & Woodward, 1926, p. 359.
Literature: Pilsbry, 1906, p. 200—203, Pl. 28 figs. 72, 73, 74. Scholten, 1913a; Van Benthem Jutting, 1933, p. 294; Stelfox, 1911; Schlesch, 1928a; Boettger, 1932; Henrard & Meeuse, 1942, p. 120.
Localities: Delft, Wageningen, Utrecht, Rotterdam, Baarn (1949).
Amsterdam, Hortus Botanicus, leg. Scholten 1912/13 (Mus. Amsterdam and Mus. Leiden); in 1949 still living there.
Leiden 1936/37 (leg. Henrard & Meeuse, in coll. Henrard); id. 1942/48.
Distribution: A native of West India and possibly also of Central America, but spread by commerce, so that it now inhabits many tropical regions of the Old and New world; introduced in greenhouses in Europe and in the U.S.A.
Remarks: Opeas pumilum was described for the first time from a Bristol greenhouse, where it was discovered as early as 1816, (Miller, 1822, p. 381) „on the boards that line a pine (bromelia) bed". Since, as Pilsbry has pointed out, Ananas bracteata, imported from Jamaica

in 1785, was the only Bromeliacea at that time cultivated in England, it is likely that the original stock of O. pumilum came in dirt around the roots, and from Jamaica. It has been found since in many places in Europe and the U.S.A. (several places in England and Ireland, see Ellis, p. 168 and Stelfox, 1911; Paris, see Bouvier c.s. and Dollfus c.s., 1896; Berlin, see Boettger, 1932; Copenhagen: specimens in Museum Amsterdam e coll. Schepman without collector or date; Pittsburgh, Pa., etc.).

The species was collected in the Hortus Botanicus, Amsterdam, by Scholten in 1912/13, where it is still to be found (Meeuse, 1949). In 1936 the species was collected together with O. mauritianum at Leiden (specimens in coll. Henrard) where it still occurs in spite of drastic rebuilding of the greenhouses there in 1938. When a careful search was made it was found in many other places in 1942/43.

The Dutch specimens perfectly agree with Pilsbry's description and also with specimens from a hothouse in Berlin (leg. Schmierer). Our finest specimens measure 7½ × 2 mm.

Though the shell is pale corneous or almost glassy and transparent in appearance, the species as well as the following one is quite characteristic in colour when alive, because the animal is bright yellow except at the top of the spire, which is coloured dark brown by the intestinal gland. The yellow and brown shine through the transparent shell.

Opeas mauritianum (Pfr.) Fig. 1, 2

Literature: Pilsbry, 1906, p. 133—135, Pl. 17 figs. 92—96; Schlesch, 1928a; Boettger, 1932; Henrard & Meeuse, 1942, p. 120.

Localities: Amsterdam, Hortus Botanicus, leg. Lütjeharms, 1926, (in coll. Henrard), 1942, 1949 (Meeuse).
Leiden, Hortus Botanicus, hothouse, leg. Pouderoyen, 1934 (Mus. Leiden); 1936—1948 (various collectors).
Delft, Cultuurtuin v. Techn. Gewassen, leg. H. Odé, 1937 (in coll. Odé and in coll. Henrard), leg. Meeuse, 1942/49.
Wageningen, Utrecht, The Hague, Baarn (1949).

Distribution: A native of Mauritus, introduced in many tropical countries. Found in greenhouses in the U.S.A.

Remarks: Most of the specimens from Dutch hothouses are not quite typical, for they usually lack the character stressed by Pilsbry

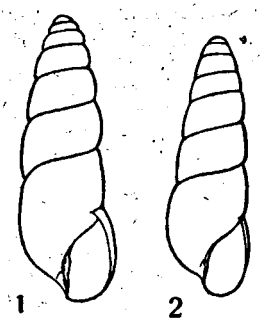

Fig. 1, 2.
Opeas mauritianum (P f r.)
1: typical form „with spire distinctly convex above", of rare occurrence in our country (e.g. a specimen from Utrecht in coll. V a n D a l s u m), the represented specimen is from Chicago (Ill.), Garfield Park, leg. J a m e s Z e t e k; 2: non-typical form with almost conical spire, common form in our hothouses (specimen from Leiden). Both × 4.

„spire distinctly convex above". For the rest they exactly resemble specimens from a Chicago greenhouse leg. J. Z e t e k (in Mus. Leiden), named by P i l s b r y himself. Our best specimens measure 9 × 2 mm. **O. mauritianum**, like the preceeding species, seems to be well adapted to a life in a hothouse, which is to be expected since it showed itself a tropical ubiquist. Especially at Leiden the species is very abundant. There it lives together with **O. pumilum** in a mixed population, the latter species occurring in much smaller numbers.
Also collected at Belfast (Northern Ireland), Botanical Gardens (leg. M e e u s e, XI-1948).

Other members of this tropical family reported from glasshouses are:
Subulina octona (G m e l.), an American species, now widely spread over the Old as well as the New world, chiefly in the tropics, which has been found in greenhouses in Ireland, Britain (see E l l i s, p. 167-168), Denmark, the U.S.A. (see S c h l e s c h, 1928a), and Germany (B o e t t g e r, 1932). Collected in Kew Gardens 1946, 1948 (see M e e u s e, 1948).
Leptinaria urichi (S m.), a West Indian species, found in a greenhouse at Cambridge (E l l i s, p. 167).
Opeas beckianum (P f r.) (York, England, see S c h l e s c h, 1928a).
O. clavulinum (P o t. et M i c h.) (Nottingham, England, see S c h l e s c h, 1928a, and collected by A. D. J. M e e u s e in a hothouse at the Royal Botanical Gardens, Kew, in April, 1946, see M e e u s e, 1948).

Varicella clappi P i l s b r y Plate III fig. 15

Literature: P i l s b r y, 1907/8, p. 109—110, Pl. 18 figs. 24 and 25.
Locality: Utrecht.
Distribution: Jamaica.

Remarks: This very interesting species was first collected by J. v a n D a l s u m (two living specimens and one empty corroded shell) in a greenhouse of the Botanical Garden at Utrecht in September 1942. Another living specimen was taken a few weeks later (M e e u s e) and still later another corroded shell and a shell fragment were found (V a n D a l s u m). Our specimens perfectly agree with P i l s b r y's

description of Varicella clappi which we quote here: „The shell is acicular, thin, glossy, whitish-corneous and somewhat transparent, composed of 7 whorls, the first 2 smooth, forming a somewhat cylindrical summit. The following whorls are sculptured, with slightly arcuate, regular and close longitudinal grooves, of which there are about 30 on the last whorl. At the periphery they disappear, leaving the base smooth. There are a few faint brown variceal streaks, about two on a whorl. The sutures are narrowly but rather deeply impressed, the embryonic and last whorls rather flattened, the intermediate ones somewhat more convex. The apeture is small, oblique, piriform. The outer lip arches forward above, and is retracted basally. The columella is deeply concave and basally truncate. The axis ascends spirally, so that in basal view a narrow false umbilicus is seen. Length 6.8, diam. 1.5 mm.

Jamaica. Types 59070 A.N.S.P., from A. D. Brown coll.

The species is closely related to V. pellucens from which it differs by the even, close grooving of all the post-embryonic whorls, and by the somewhat more slender contour.

Some specimens in the Henderson collection are of a pale brownish corneous tint. They came from the Holland collection, without exact locality. A form from Mandeville (J. B. Henderson) has the periphery and base of the last whorl smooth, and the columellar axis more sinuous, producing a larger false umbilicus, though not so large as the following form. It measures 6.9 × 1.5 mm, having 7¼ whorls."

We need only add here that the suture is somewhat crenulated at the lower side because of the ridges on the whorls, which „leave the base smooth." In our specimens the false umbilicus is almost invisible. Our specimens (collected alive) have the following dimensions: Length 5.9 mm, diam. 1.4 mm, with 7½ whorls (specimen now in our collection, leg. J. van Dalsum);

Length 5.0 mm, diam. 1.05 mm, with 7 whorls (specimen in Zoological Museum, Amsterdam, leg. J. van Dalsum);

Length 5.1 mm, diam. 1.2 mm, with 7 whorls (Museum Leiden, leg. Meeuse).

It is almost incomprehensible how this tiny Jamaican snail has found its way to the Utrecht hothouse. It is practically certain that its occurrence there is due to a direct introduction from West-India, for V. clappi has never before been reported from outside its native country. It must, in any case, have been living in the greenhouse for some years now, since the communication with extra-European territories was disrupted in May 1940.

The Oleacinidae are rapacious snails as a rule, feeding chiefly on other snails. It may be interesting to investigate the kinds of snails which are its usual prey in the hothouse.

Testacella europaea Roissy

Synonym: T. haliotidea Drap.
Literature: Schlesch, 1928a.
Locality: Gouda, in a greenhouse of a flower shop used for floriculture, leg. A. Scheygrond, December 1937, 5 specimens, in Museum Amsterdam (Miss Van Benthem Jutting, priv. comm.).
Distribution: Western Europe from Belgium and Italy to the Iberian Peninsula, England and Ireland, Algeria, Atlantic Isles. Introduced in hothouses in the U.S.A.

Remarks: This species inhabits gardens and shrubberies and may easily be imported from there into a neighbouring greenhouse. Another species of Testacella has also been found as an introduction in greenhouses in the U.S.A., viz. T. maugei Fér. (see Schlesch, 1928a).

Gonyodiscus rotundatus (O. F. Müll.)

Literature: Van Benthem Jutting, 1933, p. 308—309; Boettger, 1929a, 1929b; Holzapfel, 1932; Moszynski and Urbanski, 1932.
Localities: Het Loo, Utrecht, Leiden, Delft (Leiden from 1934 and Delft from 1937 onward), Amsterdam-H.B. (1947/1948, Schouten).
Distribution: West and Central Europe.

Remarks: Gonyodiscus rotundatus has often been reported from greenhouses. According to Boettger the shells of greenhouse specimens are usually more turreted than those of specimens living in the open and may even show a tendency to become scalariform. It was shown by cultivation in terraria with a high relative humidity, that more turreted forms are induced by the high R.H. only and appear already in the first generation. In this connection it is striking that specimens of the related G. ruderatus (Stud.) show the same change in shape of shell in one generation after cultivation in an atmosphere with high R.H. Specimens of G. rotundatus living in caves are also more turreted than those living in the open.

Our greenhouse specimens are on the average more turreted than specimens collected outside, but we noticed more or less turreted forms in both lots. We therefore have to consider Boettger's statements with some doubt until his theory has been proved by careful measurements of the shells of a great number of individuals belonging to populations living inside and to populations living outside hothouses.

Helicodiscus parallelus (Say) Plate III fig. 21, 22

Synonym: Helicodiscus lineatus (Say)
Literature: Stelfox 1911; Ellis, p. 172; Pilsbry, 1948, p. 625, fig. 339.
Locality: Leiden, 2 specimens leg. Van Dalsum and A. D. J. Meeuse, February/March 1946.
Remarks: This American representative of the Endodontidae has been found in greenhouses in various parts of England and Ireland. This is the first record of this species for the continent so far.

Retinella hammonis (Ström)

Synonym: Retinella radiatula (Alder)
Literature: Van Benthem Jutting, 1933, p. 290.
Locality: Baarn, 2 living specimens and one empty shell, 1949.
Distribution: Holarctic.
Remarks: This common indigenous snail was reported from European hothouses several times.

Oxychilus alliarius (Miller)

Literature: Van Benthem Jutting, 1933, p. 283—284; Boettger, 1930a; Schlesch, 1937.
Locality: Delft, a single specimen, leg. Caron, 1942.
Distribution: N.-W. Europe, imported by horticulture into the U.S.A., South Africa, New South Wales, New Zealand and St. Helena.
Remarks: Often reported from greenhouses, in which it is easily introduced, because it frequently inhabits places near human settlements, such as gardens, fields and wild places.

Oxychilus cellarius (O. F. Müll.)

Literature: Van Benthem Jutting, 1933, p. 280—281; Schlesch. 1937.
Locality: Utrecht, rather abundant; Amsterdam-H.B. (Schouten).
Distribution: Holarctic; introduced by man in all temperate regions of the world.
Remarks: O. cellarius is often dispersed through the agency of man and is regularly found in cultivated areas and near human settlements (Müller is said to have described his Helix cellaria from specimens taken in a cellar at Copenhagen, Denmark). It has been reported from greenhouses several times.

Oxychilus draparnaldi (Beck)

Literature: Van Benthem Jutting, 1933, p. 281—282; Bouvier c.s. and Dollfus c.s., 1896; Boettger, 1929a; Holzapfel, 1932; Moszynski and Urbanski, 1932; Urbanski, 1933.
Localities: Amsterdam-H.B., Amsterdam-Art.; Leiden (very abundant, from 1925 onward), Rotterdam (4 specimens).
Remarks: This species, which is often referred to as O. lucidum (Drap.) (Hyalinia lucida), has often been recorded from greenhouses (see e.g. Schlesch, 1937). According to Boettger (1930) it is essentially a West-European-Mediterranean snail, which is not autochthonous in

the greater part of Germany, where it is often found in gardens, parks, and wild places near human settlements. Boettger assumes that the colonies of O. draparnaldi living outdoors die out in every severe winter and that new colonies are formed after continual new introductions from its native countries, or more probably, from the populations living inside greenhouses.

In our country the species under discussion reaches the Northern limit of its natural area of distribution in the Southern part of the province of Limburg. In addition, it is found in many other localities in gardens and parks and it would seem as if these populations have originated from specimens introduced by horticulture.

Another interesting item concerning this species is the fact, first noticed by Boettger, that the occurrence of O. draparnaldi never coincides with the occurrence of other species of Oxychilus having the same habitat such as O. alliarius and O. cellarius. Boettger ascribes this to the fact that O. draparnaldi is carnivorous by preference and feeds, among other things, on the eggs and young or weak specimens of other snails, so that sooner or later it will have exterminated the other species. The coincidence at Amsterdam-H.B. can be easily explained because they were collected in different houses or in different parts of one house.

Zonitoides nitidus (O. F. Müll.)

Literature: Van Benthem Jutting, 1933, p. 288—289; Boettger, 1932; Holzapfel, 1932; Moszynski and Urbanski, 1932.
Locality: Utrecht, Baarn, Amsterdam (as early as 1927, leg. C. O. van Regteren Altena in coll. V. R. A., again from 1942 onward), Lisse, Leiden, The Hague, Rotterdam.
Distribution: Holarctic.

Remarks: Often reported from greenhouses.

The related Z. arboreus (Say), a native of N. America, was found in greenhouses in Ireland (Stelfox) and Berlin (Boettger), and run wild elsewhere in Europe (Boettger, 1929a). It was collected by the junior author in the hothouses at Kew Botanical Gardens in April, 1946 (Meeuse, 1948).

Hawaiia minuscula (Binney) Plate III figs. 19a, b, 20a, b

Synonym: **Zonitoides minusculus** (Binn.).
Literature: Stelfox, 1911; Ellis; Pilsbry, 1946, p. 420, figs. 227, 228a, b, 229: 1—3.
Localities: Utrecht, leg. Van Dalsum, leg. Meeuse (1942—1943), 15 adult and juvenile specimens; Amsterdam-H.B., 2 ad. and 1 juv. specimens (leg. Schouten, X 1947); Leiden, 1 ? juv. leg. Van Dalsum, III 1946; Baarn (1949), cf. Addendum 3, p. 30).
Distribution: North America, Hawaii (probably introduced), in hothouses in Europe.

Remarks: This species has been reported from greenhouses elsewhere in Europe, but since Baker has made a careful study of Zonitid and Pseudohyaline snails and considerably extended our knowledge of these groups (see e.g. Baker, 1929a, p. 262; 1929b, p. 87—93; 1941, p. 323), all the older references to **Zonitoides minusculus** must be considered with some diffidence. Presumably all specimens of the kind in European collections ought to be revised.

The specimens from Utrecht and from Amsterdam perfectly agree with specimens preserved under the name **Zonitoides minusculus** in the musea of Leiden and Amsterdam and also with specimens of **H. minuscula** received from the National Museum, Washington (Vermont, leg. C. B. Adams, Isaac Lea collection) and with specimens received by J. G. J. Kuiper from Dr. Pilsbry (Des Moines, Iowa, leg. H. A. Pilsbry).

The specimen from Leiden was lost in the post when being sent to Dr. H. Burrington Baker for identification and we provisionally refer it to this species awaiting the collection of more specimens; our search for more at Leiden has however so far been unsuccessful.

Arion hortensis Fér.[1])

Literature: Van Benthem Jutting, 1933, p. 256—257; Boettger, 1929a; Moszynski and Urbanski, 1932.

Localities: Utrecht (Van Dalsum, a single specimen, coll. Museum Leiden). Leiden, single specimen, leg. Meeuse; The Hague, single specimen; Amsterdam-H.B. (Schouten: occasionally).

Distribution: W. and Central Europe, introduced by horticulture elsewhere, (e.g. in the U.S.A.). Often found in greenhouses.

Remarks: **A. hortensis** inhabits gardens, fields and cultivated places generally so that its frequent occurrence in greenhouses is easily explained.

Limax maximus L.

Literature: Van Benthem Jutting, 1933, p. 262—264; Boettger, 1929a; Holzapfel, 1932; Moszynski and Urbanski, 1932.

Localities: Delft (single specimen, leg. B. J. D. Meeuse, 5 X 1942, Mus. Leiden).

Distribution: Europe, N. Africa, Asia Minor, introduced by man into North America, The Cape of Good Hope and Australia.

Remarks: **L. maximus** inhabits, among other places, gardens and buildings, so that its occurrence in greenhouses is easily explained.

Limax flavus L.

Literature: Van Benthem Jutting, 1933, p. 265—266; Boettger, 1930a.

[1]) The slugs were treated by C. O. van Regteren Altena. Additional records were supplied by A. R. Schouten.

Localities: Rotterdam, a single specimen, autumn 1942, Pouderoyen leg. (Mus. Leiden), Amsterdam-H.B. (Schouten, 1 juv., among the roots of Phoenix).

Distribution: Limax flavus is, according to Boettger, originally a native of the dry regions of the Levant, W. Asia and N. Africa, where it is found in the open. In W. and Central Europe L. flavus is exclusively found as an anthropochore in cellars, outbuildings and gardens. Introduced into Japan, the Americas, Australasia and S. Africa.

Remarks: This slug is really the most domestic of our molluscs, so that its occurrence in greenhouses is to be expected.

The state of preservation of the specimen collected at Rotterdam was not quite satisfactory, but the anatomical investigation showed the presence of a well developed caecum of the rectum, in addition to the external characters, so that the determination is certain.

Deroceras reticulatum (O. F. Müll.)

Literature: Van Benthem Jutting, 1933, p. 268—270; Boettger, 1929a; Holzapfel, 1932.

Localities: The Hague, a single specimen, 4 XI 1942 (leg. Meeuse in Mus. Leiden), Amsterdam-H.B., regularly (Schouten).

Distribution: Europe and Northern Asia, but making itself at home wherever European colonisation has extended.

Remarks: This destructive slug is most ubiquitous and its occurrence in greenhouses is easily explained thereby. The related D. agreste (L.) is reported by Miles and Miles (1935) as injurious to glasshouse crops.

Deroceras laeve (O. F. Müll.), s.l.

Literature: Boettger, 1929a, 1931a, 1932; Holzapfel, 1932; Meeuse, 1948; Pilsbry, 1948, p. 539 seq., figs. 289—291.

Localities: Utrecht, 1 specimen, leg. R. A. Maas Geesteranus, 30 IX 1942 (Mus. Leiden); 1 specimen, leg. Meeuse, XI 1942.
Amsterdam, 2 specimens, leg. Meeuse, 24 X 1942 (Mus. Leiden); since 1946 regularly in palm house and in „cold" succulent house (Schouten, Meeuse); Amsterdam-Art., tropical house, 17 X 1947 (Schouten), 1 ad., 1 juv.
Leiden, 5 specimens collected (many more were observed), IX and X 1942, 2 in Mus. Leiden.
Rotterdam, 1 spec., leg. Pouderoyen, X 1942 (Mus. Leiden).
Delft, very abundant and injurious to orchids in an orchid house, leg. Meeuse, 1944 (Mus. Leiden and Coll. Hubert and Meeuse).
Juvenile specimens, most probably belonging to this form were collected at Wageningen (1 specimen, leg. Meeuse, II 1943) and The Hague (2 specimens, leg. Meeuse, 4 XI 1942, in Mus. Leiden).
Baarn (4 specimens, leg. Holthuis, Meeuse, and Van Regteren Altena, 8 IV 1949, in Mus. Leiden).

Distribution: Typical form holarctic. The form referred to D. l. sandwichiense (Eydoux et Souleyet) by Boettger (1931a) known from many tropical countries (Hawaii, Australian region, Madagascar, S. America and this, or another form also from moderate areas as Southern Chili and the Far-Oer (Boettger, l.c.). Also reported

from Java (H. Hoffmann, 1941). Some forms, different from the typical one, imported in European hothouses (see below).

Remarks: The relationship of the various forms which are usually included in „D. laeve", but which have so far not been conclusively proved to belong to one and the same species, is far from clear. Cultivating experiments on a large scale with material of various origins seem to be the only method to decide in this matter. The most recent survey of the questions to be solved was given by Pilsbry (1948).

In the hothouses we found, in the first place, a rather large form, externally recognisable by its purplish hue. As regards their anatomy, these specimens always lacked a penis and a vas deferens (specimens from Leiden, Amsterdam-H.B., Utrecht and Rotterdam). We consider this form to be identical with the one referred to as D. l. sandwichiense (Eyd. et Soul.) by Boettger.

A. R. Schouten collected specimens in the palm house of the Botanical Gardens, Amsterdam, of a slightly smaller form, colour tawny olive (Ridgeway) without the purplish hue, but also aphallic. In the „cold" succulents house of the same Bot. Garden Schouten found euphallic specimens (but with the retractor penis lacking) of a paler colour than the ones from the palm house. These two forms were cultivated by Schouten at normal room temperature and he observed small differences in shape, in their behaviour and in the shape of their eggs, which gave him the impression that the two forms are true-breeding.

According to Boettger (1931a) D. laeve sandwichiense differs from the typical D. l. laeve (O. F. Müll.) by the fact that penis and vas deferens are lacking. Minor morphological points of difference are the more purplish (instead of reddish brown) colour and the greater body length (up to ± 25 mm instead of ± 20 mm) of D. l. sandwichiense. The typical form inhabits Europe and is normally hermaphrodite, though sometimes specimens with more or less reduced penis are found. Boettger has made an elaborate study of the subject and deduced that, when D. laeve was introduced into foreign countries, the hermaphrodite form changed under the prevailing circumstances into the form with reduced male reproductive organs, which is able to breed by some sort of internal self-fertilisation. The form sandwichiense is able to reproduce rapidly, so that it soon became a tropical cosmopolite and Boettger maintains that it has reached the status of a true geographical race. According to this train of thought, the form was subsequently re-introduced into European greenhouses. In this connection it is noteworthy that Kraepelin (1901) has actually observed slugs resembling D. laeve, which were introduced into Hamburg from South America.

An alternative to this hypothesis is that the forms with reduced penis, already capable of self-reproduction, were introduced into the tropics and spread rapidly by reason of their favourable reproductive capacities.

Another alternative, as far as the hothouse specimens are concerned, is, that specimens of typical D. laeve were introduced into a greenhouse from nearby and changed into the form sandwichiense under the prevailing ecological circumstances. In our opinion, the solution of the problem can, if ever, only be found after careful cultivating experiments with both forms under different physiological conditions. For details we refer to Boettger's paper.

Boettger has drawn the attention to the fact that Stelfox mentioned specimens of D. laeve from Irish greenhouses, which „differ from our native examples ..... in their colour, which is of a peculiar slaty-purple tinge" (Stelfox l.c.). Boettger concluded from this description that Stelfox also had the form sandwichiense before him.

Trichia hispida (L.)

Literature: Van Benthem Jutting, 1933, p. 326—328; Moszynski and Urbanski, 1932.
Localities: Utrecht (a single specimen); Leiden (a single juvenile specimen); Delft (a few empty shells, possibly introduced after the death of the animal).
Distribution: Central Europe.
Remarks: The specimens collected were possibly incidental introductions and the occurrence of the species in hothouses seems only transitory. T. hispida is reported from hothouses in Poland.

Helix aspersa O. F. Müll.

Literature: Van Benthem Jutting, 1933, p. 346—348.
Locality: Delft, a single juvenile specimen (leg. B. J. D. Meeuse 1942).
Distribution: W. and S. Europe, N. Africa. Introduced in many countries by horticulture (U.S.A., South Africa, Réunion, Australia).
Remarks: In our country this snail occurs exclusively near human settlements. The specimen taken was apparently an occasional introduction and seems to have been introduced from the immediate surroundings of the greenhouses, for the species is of common occurrence in the gardens at Delft.

LAMELLIBRANCHIA

Sphaerium lacustre (O. F. Müll.)

Literature: Van Benthem Jutting, 1943, p. 197—199.
Locality: Leiden, abundant in mud of a basin in Victoria house (1942); mostly juvenile specimens.
Distribution: Europe, N. Asia.

Remarks: This species occurs in the open in the Botanical Garden at Leiden and has apparently been introduced into the Victoria house with mud or with water plants.

5. Some general aspects of the mollusc fauna of glasshouses

The mollusc fauna of our greenhouses is composed of elements of different origin. A certain number of species is autochthonous and has apparently been introduced into the greenhouses from nearby. Representatives of this group of species are **Ancylus lacustris, Bithynia tentaculata, Carychium minimum, Cochlicopa lubrica, Galba palustris, Gonyodiscus rotundatus, Lymnaea stagnalis, Sphaerium lacustre, Oxychilus alliarius,** several species of **Radix, Trichia hispida, Vallonia costata, V. pulchella** and **Zonitoides nitidus.**

A second group consists of species originally introduced by horticulture, but at present so well established that they can hardly be separated from the true native species. Representatives of this group are **Limax flavus, Oxychilus draparnaldi** and **Helix aspersa. Arion hortensis, Limax maximus, Deroceras reticulatum** and **Oxychilus cellarius** form a sort of link between these first two groups, because they are probably autochthonous, but have become anthropochores as well.

The third group consists of exotic species.

The indigenous species usually do not show any features due to the change in environment. An exception is made by **Gonyodiscus rotundatus** (see p. 20). Striking among the indigenous species is the relatively high number of aquatic molluscs as compared with the greenhouse fauna recorded from elsewhere in Europe. This obviously has to be ascribed to the fact that our country is so rich in ditches, canals and pools, that the chance of their being introduced is much greater than in other countries.

The second group of species, those spread over large areas of the world by horticulture, is of little interest. Their occurrence in glasshouses of all kinds is to be expected, because they are adapted to a life on cultivated soil.

An analysis of the third category of species shows that most of them have already been reported from greenhouses in other parts of Europe (e.g. **Deroceras laeve sandwichiense, Pseudosuccinea columella, Opeas mauritianum, O. pumilum, Helicodiscus parallelus, Hawaiia minuscula**). The original mode of introduction of these species in the Netherlands is unknown, but it would seem probable that they are of „secondary" origin and were introduced from another European hothouse. Examples of exotic animals which have certainly been introduced in hothouses in this way have been given by M o s z y n s k i and U r b a n s k i, who showed that a complex of newly built greenhouses at Poznań (Poland) possessed a rich exotic fauna after a couple of years, though direct imports of exotic plants from tropical countries had never taken place. The only possible

method of introduction had been with the plants which were received from hothouses and growers in Europe. We were able to find a similar secondary introduction, viz. the introduction of **Pseudosuccinea columella** in Rotterdam with aquatic plants received from Leiden (see p. 12).

Apart from the exotic species mentioned above, we found a number of species not recorded from glasshouses hitherto. They are of special interest because they may either be introduced into other greenhouses, so that the number of localities will increase in the next few years or remain restricted to one or a few localities and eventually die out again. The new records are **Thiara tuberculata, Helisoma nigricans, Isidora proteus, Radix javanica** and **Varicella clappi**. Some of these species were already in cultivation for some years and have escaped from captivity (**Thiara, Helisoma, Isidora**), the others apparently being introduced unintentionally.

6. Literature

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7. Addenda

1. **Thiara tuberculata** was discovered in a consignement of water weeds, received at Delft (Cultuurtuin v. Technische Gewassen) from the Botanical Gardens (hothouses), Utrecht (B. D. J. Meeuse, May 1949). This is a beautiful example of the „passive" migration of introduced exotic animals from a hothouse to another locality. It is not unlikely that **Th. tuberculata** will establish itself in the hothouses at Delft in the near future as a result of this recent introduction.

2. In 1949 **Pseudosuccinea columella** was fairly abundant at Baarn. It was not found in 1942 or 1943, but it is not very likely that the species had been overlooked. Most probably the species was introduced between 1943 and 1949 from some other locality in the Netherlands.

3. In 1949 two half-grown (± 3 whorls) specimens of **Hawaiia minuscula** were taken at Baarn. They perfectly agree with those from other localities and we consider them to be conspecific.

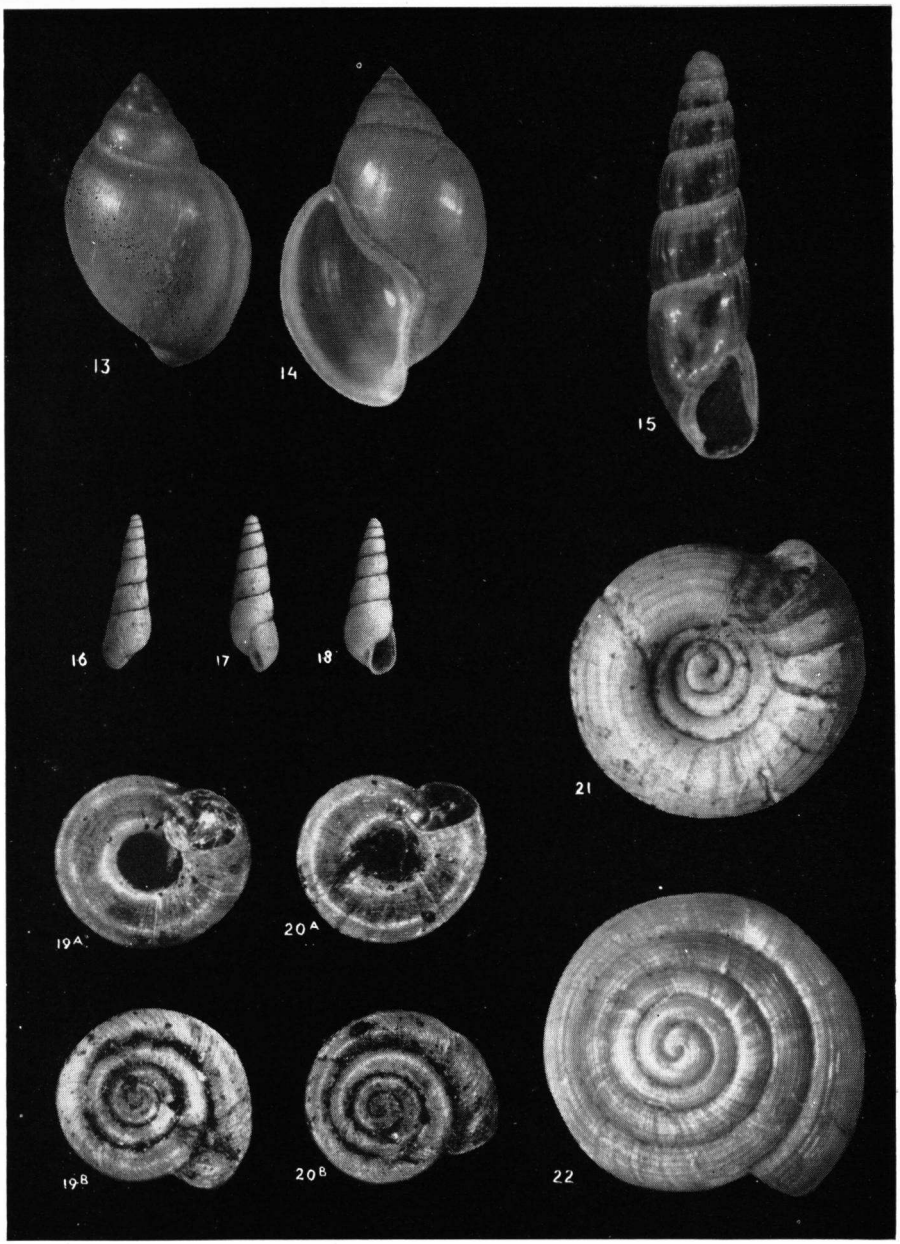
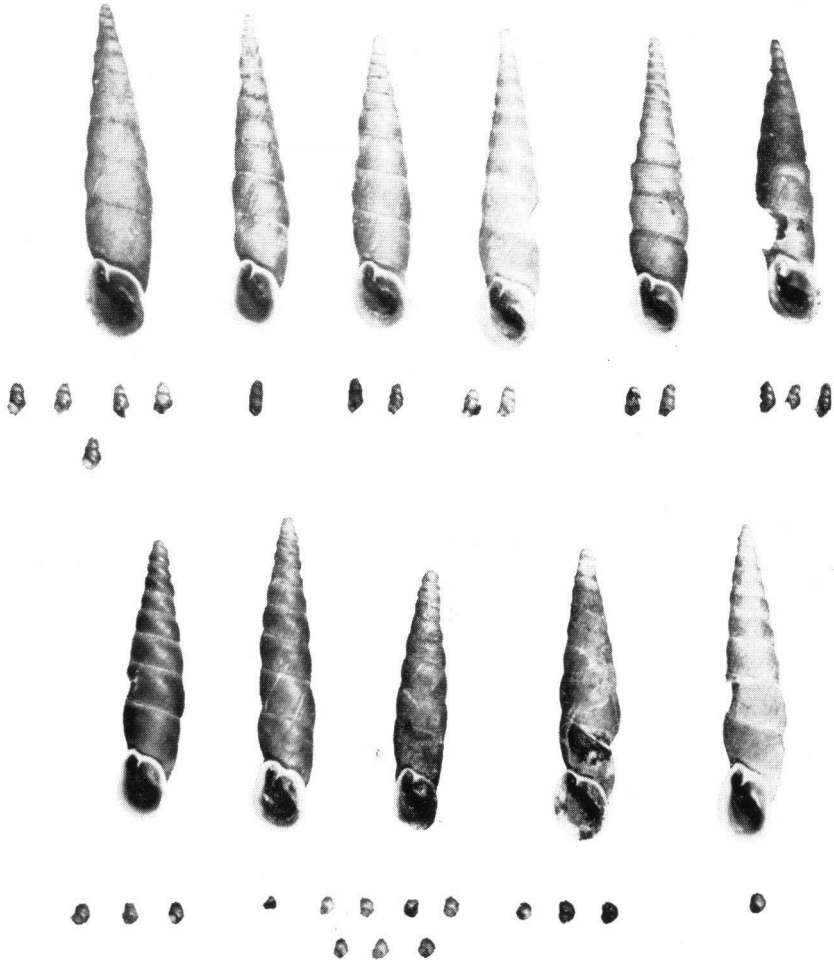


Fig. 13, 14. **Physa acuta** Draparnaud, two shells from the Victoria house, Leiden, × 3. Fig. 15. **Varicella clappi** Pilsbry, specimen from Utrecht, Van Dalsum leg. in collection Hubert & Meeuse, × 11. Fig. 16, 17, 18. **Opeas pumilum** (Pfeiffer), three shells from Wageningen. Notice the slightly receding free margin of the aperture, characteristic of this species (central specimen), × 4. Fig. 19a, b, 20a, b. **Hawaiia minuscula** (Binney), two specimens from Utrecht, Van Dalsum leg., × 13½. The specimen of fig. 19 with abnormal position of last whorl near aperture. Fig. 21, 22. **Helicodiscus parallelus** (Say), the two specimens from Leiden, × 15.

PLATE IV



Upper series: six shells of **Phaedusa (Phaedusa) paviei** Morlet, with the embryonic shells got out of them, × 1½.
Lower series: five shells of **Phaedusa (Phaedusa) phongthoensis** n. sp., with the embryonic shells got out of them, × 1½.