

**Alderia modesta (LOVÉN) and
Limapontia depressa ALDER & HANCOCK
in the brackish waters of the Dutch coast**

by

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The following records of two species of Sacoglossa in the Netherlands induced us to some observations and to the study of the literature, the results of which are given here.

Alderia modesta (L o v é n)

1) many specimens on *Vaucheria* patches on the mud along the bank of the Nieuwe Waterweg, at the N. coast of the Island of De Beer, opposite Hoek van Holland, Aug. 24 1939, leg. S. J. Geerts and C. O. van Regteren Altena.

2) many specimens on *Vaucheria* in tidal creeks of the "Schorre", called the "Rietmoeras", at the SE. coast of the Island of De Beer, Aug. 24 1939, leg. S. J. Geerts and C. O. van Regteren Altena.

3) many specimens at the same localities, Sept. 29 1939, leg. H. Engel and S. J. Geerts.

Limapontia depressa Alder & Hancock

4) some few specimens on fine algae in small pools with water in a creek of the "Schorre" in the Northern Sloe (province of Zeeland), between the railway-embankment and Caland-schorre, Sept. 1 1939, leg. C. Brakman.

Limapontia depressa Alder & Hancock, var. *pellucida* Kevan

5) many specimens, locality and date as 2).

6) several specimens, locality exactly as 2), date as 3).

Acknowledgements

We seize this opportunity to thank Mr. C. Brakman for the kind way in which he put his animals and his notes at our disposal. We are indebted to Prof. Dr. L. F. de Beaufort for the identification of *Gobius microps*, to Miss A. P. C. de Vos for that of the Oligochaets, Polychaets and Harpacticids, to P. Wagenaar Hummelinck for the

name of *Laomedea gelatinosa*, while Dr. J. Heima n s was so kind as to identify the algae. We owe the beautiful figures a-g of Plate 2 to the skilful hand of Mr. P. K a a s.

Synonymy

Noting the slight differences between *Limapontia capitata* (*nigra*) and *L. depressa* we studied the whole literature on the genus *Limapontia* and for the convenience of later students give it here. As to *Alderia modesta* we confined ourselves to the species. We tried to summarise in a few words the subjects treated in each paper. Such papers as the "Tierwelt der Nord- und Ostsee" i.a. that give no new facts were omitted, while others that only mention a new locality were quoted with an asterisk.

Alderia modesta (Lovén)

Stiliger modestus — Lovén 1844, p. 49 (Bohuslän, Sweden; in limo, locis parum profundis; Odhner 1907, p. 91, defines it more precisely as: Kåringön, 1834).

Alderia amphibia Allman M. S. — *Thompson 1844, p. 250 (S. coast of Ireland).

Alderia... — Allman 1845, p. 65 (preliminary note; amphibious on *Enteromorpha intestinalis* and other plants, almost beyond the reach of the tide, in salt marshes in S. Ireland).

Alderia modesta — Allman 1846, p. 1 (species described and identified with Lovén's animals; from Skibbereen, Co. Cork) — *Lovén 1846, p. 8 (Bohuslän) — Spence Bate 1850, p. 7, pl. 1, f. 1 (near Swansea in a brackish ditch in May on Confervae and later on the bank. We could not see this paper. The figure is reproduced by Forbes & Hanley 1851, I, pl. CCC, f. 1) — Alder & Hancock 1851-'52, Fam. 3, pl. 41 (animal and its eggs after Allman's and Spence Bate's specimens), pl. 43, f. 17-19 (penis, radula) — Alder & Hancock 1862, p. 265 (with *Limapontia depressa* at Hylton Dene near Sunderland) — Brady 1863, p. 151 (not seen) — *Brady 1864, p. 100 (description of the locality Hylton Dene near Sunderland) — *Brady 1869, p. 121 (idem) — Alder in Jef-

freys 1869, p. 32 (no news) — *Norman 1893, p. 351, (shallow pool reached by the sea only at spring-tide, Trondhjem Fjord; see also Odhner 1926, p. 30) — Luther 1902, p. 41 (brackish beach-pool in Fölisön Is. near Helsingfors; 1,669 — 2,556 gr. Cl (= 2,8 — 4,21 gr. NaCl) per L., important) — Farran 1905, p. 208 (in muddy hollows with algae at the margin of experimental oyster ponds at Ardfry (Co. Galway, Ireland), near the head of Galway Bay, at the level of high water at spring tides) — Eliot 1906, p. 376—379, pl. XI—XII, f. 25—30 (very important description of the animal and its anatomy after specimens from Farran's locality and notes of Hancock) — *Odhner 1907, p. 91 (harbour of Malmö, 7—8 fms., among *Zostera* and algae; Skelderviken, both Baltic) — Eliot 1910, p. 137, 177, pl. VII, f. 3—6 (about the same text as 1906, without the anatomical plates, but with beautiful figures from living animal by Hancock) — Levander 1914, p. 51 (Tavastfjord, W. of Porkala, near Helsingfors, in brackish water, temp. 19° C., salt 5,03 ‰) — *Vaysière 1913, p. 232 — Gallien 1929, p. 18, 162 (important description of habitat and animals) — Kevan 1934, p. 16 (Tyne mouth, salt marsh at springtide level. Important paper) — Nicol 1935, p. 216, 221 (Salt marsh in Aberlady Bay, S. coast of Firth of Forth; ecology) — Schulz 1936, p. 41 (Kielerbucht on *Vaucheria*, important observations on the animals and their early development) — Friedrich 1937, p. 101 (important physiological experiments on the osmoregulation of the same specimens; the lower limit of normal life lies at a salinity of 5—8 ‰) — Feliksiak 1936, p. 299, f. 1—3 (in brackish water near Wielka Wiés, W. of Danzig) — Kevan 1939, p. 160 (important further observations on habitat and breeding season) — Adam & Leloup 1939 (important new paper on animals from the river Scheldt, just published).

Alderia Scaldiana — Nyst 1855, p. 435, f. 1, 2 (amphibious on the banks of the brackish Scheldt between Antwerp and fort Philippe) — *Gilson 1914, p. 23, f. 7, p. 64, f. 50, 51 (only 3 photographs of localities very typical of this species on the margin of the "Westerschelde": island of Saeftinge, 1912) — cf. Adam & Leloup 1939, p. 1.

Alderia modesta? — Kerbert 1918, p. 76 (brackish Zuiderzee near Durgerdam, on stones with *Enteromorpha* (also Van Benthem Jutting 1922, p. 401); Engel 1936, p. 109 (see also Van Benthem Jutting & Engel 1936, p. 37) considered this record as doubtful, but since he knows the animal and the conditions in which it lives, the record seems very probable to him).

Limapontia capitata (O. F. Müller)

Fasciola capitata — O. F. Müller 1773, p. 70 (in Mari Balthico. To us, as to Meyer & Möbius, this seems a synonym of *L. nigra*, because the animal is "postice acuminato" and because the eye is situated in the upper outer angle of the white area on the side of the head. Alder & Hancock 1862, however, think it comes nearer to *L. depressa*).

Planaria capitata — *O. F. Müller 1776, p. 223, n. 2701.

Planaria limacina — O. Fabricius 1826, p. 23, Pl. II, f. 1—6 ("i Strandvandet isaer paa *Conferva polymorpha*"). We think this must be the present species because of the pointed tail (beautiful figures!), which never occurs like that in *L. depressa*.

Limapontia nigra — Johnston 1836, p. 79, f. 14 (Berwick Bay, on marine *Confervae*) — *Lovén 1846, p. 8 (Norwegian coast, Cape Kullen in Kattegat) — Leuckart 1847, p. 140 (Heligoland) p. 143 (perhaps *Limapontia* is a young Eolid?) — Alder & Hancock 1848a, p. 402, pl. XIX, f. 4—6 (in small pools among the rocks between half tide and high water marks feeding upon *Conferva glaucescens* at Falmouth; on *Conferva glaucescens* with eggs (figure) in shallow pools on the rocks, in warm weather on the surface of the *Conferva* at Cullercoats; Whitburn) — *Schultze 1849, p. 270 (Greifswald) — ? Spence Bate 1850, p. 7, pl. II, f. 4 (near Swansea; Alder & Hancock think this animal was identical with *L. depressa*. We could not see this paper) — Forbes & Hanley 1851, I, pl. CCC, f. 4 (figure after Alder & Hancock 1848a), III, p. 614) — Dalyell 1853, p. 318 (Firth of Forth, till Eyemouth) — *Lindström 1855, p. 68 (near Wisby and near Stockholm) — *Danielssen 1859, p. 38 (along the whole Norwegian coast on the beach, no notes on the

- animals themselves) — *Taslé 1867, p. 46 (Golfe du Morbihan on the rocks between Hydrophytes) — *Taslé 1868—9, p. 212 (Brest, Finistère, on *Cladophora*) — Alder in Jeffreys 1869, p. 28 (no news), pl. I, f. 5 (after Meyer & Möbius) — *Fischer 1872, p. 18 (coast of Finistère) — *Friele & Hansen 1876, p. 79 (Norwegian coast up to Hammerfest) — *Norman 1879, p. 34 (Shetland islands, Denmark, Bergen Fjord) — *Daniel 1883, p. 369 (roads of Brest, on *Cladophora*) — Graeffe 1903, p. 105 (in algae on the shore at Trieste) — Eliot 1910, p. 141 (short but important anatomical remarks; Pelseneer's description of *L. depressa* is wrongly referred to the present species!).
- ? *Vortex littoralis* — Ørsted 1844, p. 64, pl. 2, f. 22—23 (*non vidimus, fide* Mörch 1871).
- Chalidis nigricans* — Alder & Hancock 1847, p. 748 (= 1848₁, p. 73) (Falmouth).
- Limapontia capitata* — Mörch 1864, p. 382 (Kallebodstrand, Denmark) — Mörch 1871, p. 185 (Kallebodstrand, Liimfjord, Bornholm, Gotland) — Bergh 1873, p. 207, pl. XXVI, f. 18—22 (Kallebodstrand near Copenhagen, Liimfjord in Jütland, Kattegat, Kieler Bucht (specimens from Möbius); radula, anus at 2/3 of the length, penis) — v. Jhering 1877, p. 199 (nervous system only) — Sars 1878, p. 323 (whole Norwegian coast), pl. XVI, f. 16 (radula tooth) — *Nobre 1884 (not seen) — *Herzenstein 1885, p. 712 (Murmancoast, N. Russia) — Vayssière 1888, p. 146 (Gulf of Marseille), pl. II, f. 7, 7a, pl. VII, f. 120, 121, 122 (beautiful figure, describes radula and penis) — Pfeffer 1890, p. 90 (Murman coast) — Scott 1889, p. 324, 325 (tidepools Newhaven in Firth of Forth; not seen) — Garstang 1890, p. 422 (on *Cladophora* in tidepools in Cawsand Bay near Plymouth, also in pools drying out at neap tide at Lytham on the Lancashire coast) — *Norman 1890, p. 91. (Cumbræ, St. Andrews) — Nobre 1896, p. 108 (Rochedos de Leixoes, Foz de Douro) — *Beaumont 1900, p. 852 (among algae between tide marks at Reenagiveen, Church Island and Cahir River (on muddy ground), all Valencia Harbour, Ireland) — *Norman 1902, p. 351 (between tide marks, Vadsö, East Finmark) — Vayssière 1903, p. 92 (eggs, larva) — *Anonymus 1904, p. 278 (Plymouth) —

Farran 1905, p. 209 (near tide pools, with *Alderia modesta*; the type of locality rather points to *L. depressa*) — *Odhner 1907, p. 92 (Göteborg, Finmark) — *Levander 1914, p. 52 (with *Alderia modesta* near Helsingfors) — Vayssière 1913, p. 242 (figured and mentioned in his Faune de France) — *Odhner 1922, p. 45 (Hammerfest, Manger on Confervae; Farsund) — *Iredale & O'Donoghue 1923, p. 198 (list) — *Cuénot 1927, p. 261 (Arcachon, in green algae, July—Sept.) — Lemche 1929, p. 24 (in a pool between tide marks at Giljanes, Sandevaag (Vaagø), Faroer) — Si 1931, p. 137, 150, 199, f. 62, 63 (Toulon, on *Cladophora*, eggs) — Vayssière 1930 (recapitulation) — *Nobre 1932, p. 49, pl. 11, f. 7 (Rochedos de Leixoes, Foz do Douro, on algae) — Kevan 1934, p. 16 (Aberlady, 10 miles W. of Tynemouth, and in Tynemouth) — *Feliksiak 1936, p. 303 (with *Alderia modesta* in brackish nearly fresh water in Wiek of Puck, W. of Danzig) — Wohlenberg 1937, p. 27 (Sylt, *Salicornia* — *Zostera nana*-zone) — *Seifert 1938, p. 247 (S. of island of Rügen) — *Seifert 1939, p. 20 (W. of island of Rügen) — Kevan 1939, p. 160—162 (habitat and breeding season) — *Odhner 1939, p. 13 (Ålesund, Holmen in Volsdalsvåg, Flatholmen; both Norway).

Pontolimax varians — F. Müller 1848, p. 1 (first cleavage stages of egg, mentions the name *Pontolimax varians* as a museum name of Creplin (quoted in Schultze 1849, p. 273, also mentioned as occurring on the Baltic coast near Greifswald, p. 270)).

Pontolimax capitatus — Meyer & Möbius 1865, p. 3 (Kieler Bucht, Bornholm; beautifully figured, describes radula and eggs) — *Lindström 1868, p. 31 (Gotland, on seaplants near the beach) — *Möbius 1873, p. 131 (Kiel on seagrass, 1—5 fms; Bornholm, 1—3 fms, on plants on the beach) — Palmén 1881, p. 129 (near Helsingfors) — *Heincke 1896, p. 134 (Heligoland, "an Pflanzen der Kreideklippen") — *Levander 1899 (Esbo—Löfö near Helsingfors).

Limapontia islandica — *Mörch 1868, p. 205 (Iceland, no details).

Limapontia capitata, var. *islandica* — Bergh 1873, p. 209, pl. XXVI, f. 23, 24 (specimens of Mörch from Iceland, not different from typical species).

Limopontia [sic] *capitata* — Nicol 1935, p. 215, 216, 221
(Firth of Forth, salt marshes on *Vaucheria*).

***Limapontia depressa* (Alder & Hancock)**

Limapontia nigra — Spence Bate 1850 (non Johnston), p. 7, Pl. II, f. 4 (near Swansea, we could not see this paper, but Alder & Hancock consider the species identical with *L. depressa*).

Limapontia depressa — Alder & Hancock 1862, p. 264 (Hylton Dene near Sunderland, in brackish pools with *Alderia modesta* on a *Conferva* (*Vaucheria submersa*?)) — Brady 1864, p. 100; 1869, p. 121 (in brackish pools at Hylton Dene near Sunderland, with *Alderia modesta*) — Hancock in: Tynes. Club Trans. V, p. 515, pl. 17 (fide Alder in Jeffrey's) — Alder in Jeffrey's 1869, p. 29 — Pelseneer 1893, p. 62—64, pl. 21 (Wimereux near Calais, complete anatomy, important) — Petch 1903, p. 32 (not seen) — Eliot 1910, p. 142, pl. VII, f. 7—9 (reproduces some unpublished figures by Alder & Hancock) — Gallien 1929, p. 31, 170 (interesting description of habitat and animals; he sees that the animal emits mucus from an orifice in the middle of the right side to defend itself against Copepod-attacks) — Pelseneer 1934, p. 54 (a summary of what is known till now).

Limapontia depressa, var. *pellucida* — Kevan 1934, p. 16 (Tyne-mouth, description of var., with interesting particulars about its habitat and habits. The author supposes that the animals do not hatch until another spring tide, a fact well consistent with Gallien's observation on the eggs lying unchanged in the mud for some time) — Kevan 1939, p. 160—162 (habitat and breeding season).

***Limapontia coerulea* (De Quatrefages)**

Chalidis coerulea — De Quatrefages 1844, p. 155, (in the *Fucus*-zone, Ile de Bréhat), pl. III, f. 7 (specimen), pl. IV, f. 4, pl. V, f. 8, pl. VI, f. 7, 10 (anatomy).

Limapontia coerulea — *Fischer 1867, p. 12 (quotes Quatrefages) — Taslé 1868, p. 73 (not seen, after Locard 1885, p. 64: rocks in the Gulf of Morbihan).

Limapontia zonata (Girard)

Niobe zonata — Girard 1852, p. 210 (Boston Harbour).

Limapontia zonata — *Stimpson 1860, p. 4 (fide Binney) — *Binney 1870, p. 258 — *Jeffreys 1872, p. 242.

Limapontia spec.

Pontolimax sp. — *Ostroumoff 1893, p. 246 ("Mer Noire et d'Azow").

? **Limapontia cornuta (Giard)**

Limapontia cornuta Giard — Gallien 1929, p. 31 (we have been unable to find the original description of this species, Gallien says that it was found in the intertidal zone at Wimereux near Calais and stands very near *L. capitata*).

Distribution (Plate 1)

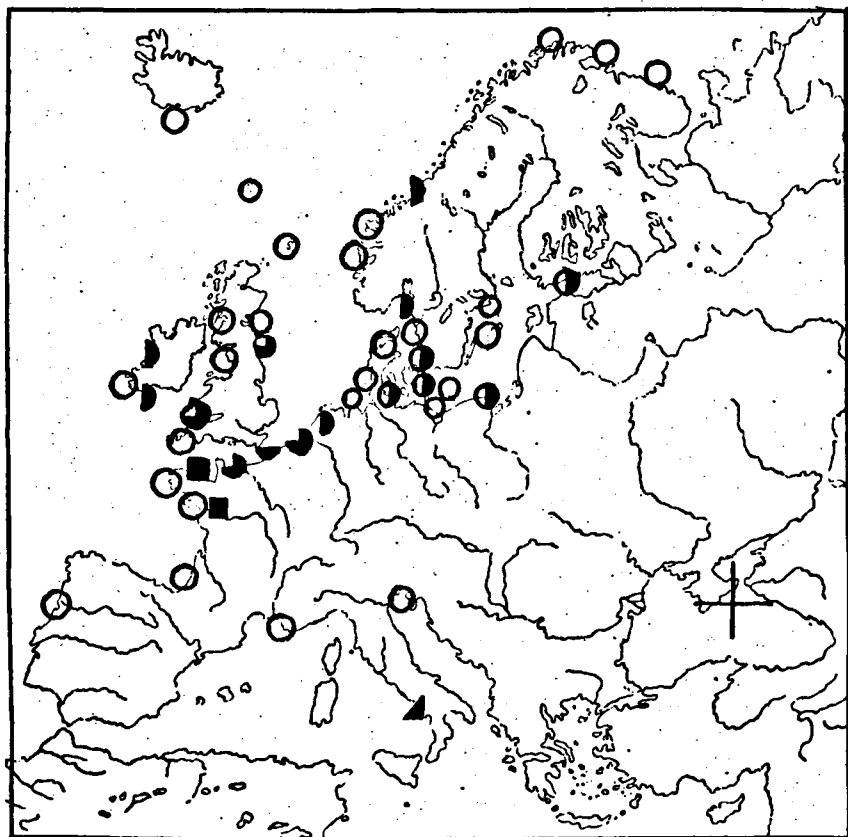
From the literature combined with our new records the distribution of the species dealt with appears to be as follows.

Alderia modesta: Trondhjem, Swedish coast of Kattegat and Öresund, Gulf of Finland, German coast of the Baltic, formerly the Zuiderzee (now IJsselmeer, where it is surely extinct), estuaries of Rhine and Scheldt, N. coast of Normandy, environment of Newcastle, neighbourhood of Swansea, S. coast (Co. of Cork) and W. coast (Co. of Galway) of Ireland.

On the map another European *Alderia* viz. *A. comosa* from Naples has also been recorded (see Vayssière 1913, p. 232).

Limapontia capitata: Murman coast, Finmark coast, coasts of the Scandinavian Peninsula up to Stockholm, Baltic sea S. of the line Stockholm—Helsingfors, Island of Sylt, Heligoland, Iceland, Faroer, Shetlands, E. coast of Scotland and England from St. Andrews to Sunderland, S. coast of Cornwall and E. coast of England and Scotland from Plymouth to Cumbræ, Valencia Harbour (SW. coast of Ireland), S. coast of Brittany, Arcachon, near Porto, Marseille, Toulon, Trieste.

Plate 1



Distribution of *Alderia* and *Limapontia* in Europe.

◐ *Alderia modesta* (Lovén), ▲ *Alderia comosa* Costa,
 ○ *Limapontia capitata* (O. F. Müller), ◑ *Limapontia de-*
pressa Alder & Hancock, ■ *Limapontia coerulea* (De
 Quatrefages), + *Limapontia spec.* (the signs ◐, ◑ and ○
 have eventually been combined).

Limapontia depressa: Tyne mouth, Sunderland, estuaries of Rhine and Scheldt, Wimereux, Calvados coast (Normandy), Swansea.

Limapontia coerulea: Island of Bréhat (N. coast of Brittany), Morbihan.

Limapontia zonata: Boston.

"*Limapontia cornuta*": Wimereux.

Limapontia spec.: Black and Azow Sea.

Description of the specimens in hand

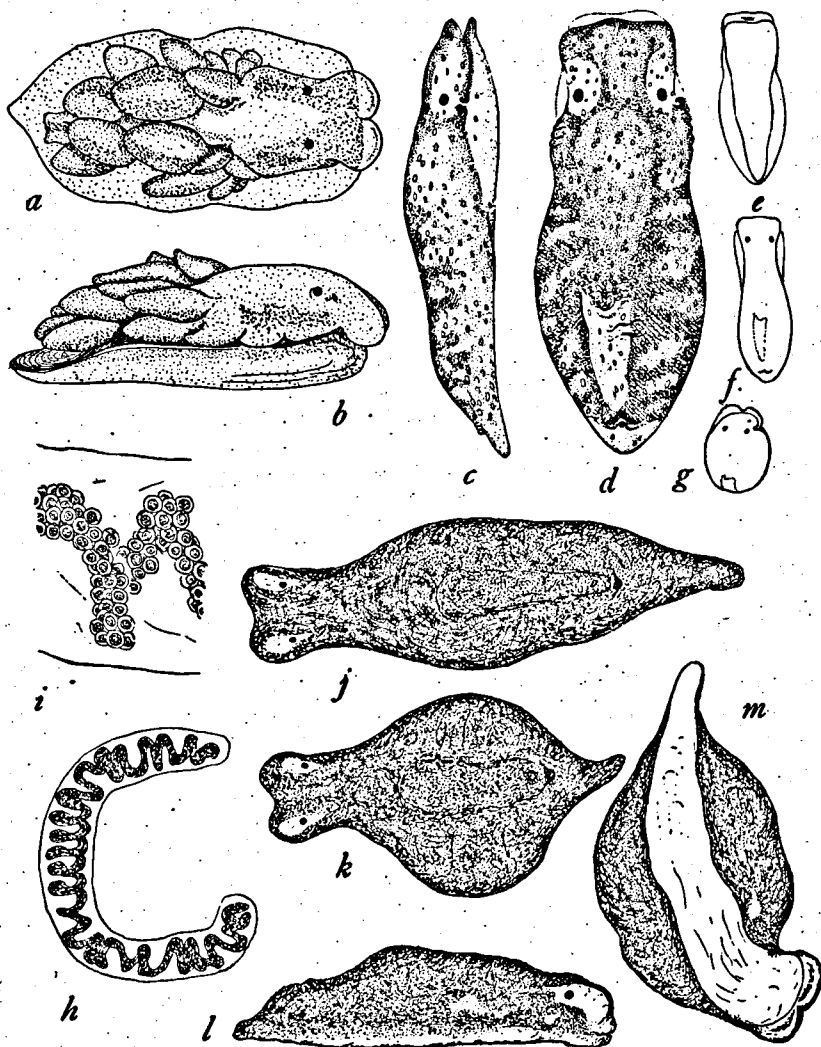
Alderia modesta. (Plate 2, f. *a, b*). Our specimens had the following dimensions: length: from less than 1 to 6 mm., breadth: 1 to 3 mm., height: $\frac{1}{2}$ to 2 mm., they showed differences in colour due to differences in quantity and colour of the contents of the diverticles of the intestine. A fine black pigment covered the dorsal surface of the head and the back between the papillae, often also the papillae themselves. The animals had about the same colour as the *Vaucheria* on which they were found. In about 100 specimens the variation of the number of papillae proved to be from 3 to 23 on each side; the number was nearly equal in the two sides, the left side usually having 1 or 2 papillae more than the right one. It is impossible to distinguish exact longitudinal or transversal rows, but the papillae number about 1—3 on each side in a transversal section. The anal tube is always quite distinct; the foot has a distinct margin all round. The margin of the head can change its form; it can look bilobed or rounded or take any other form that its reactions to the surroundings call forth. In the living animal it is possible to observe the backward stream of water caused by the ciliae on the side of the foot.

Limapontia depressa (Plate 2, f. *j—m*). We could examine some of Brakman's specimens preserved in alcohol. They were very broad, but a sketch by Brakman, made from the living animal, shows that they had the usual shape of this species. The colour of the living animals was described by Brakman as brown with some irregular yellowish patches,

while a slightly lighter area indicated the heart; the foot also was yellow. The length amounted to 4—5 mm. Afterwards Brakman found a great number of young specimens (1. XI. 1939; some more on 20. XI. 1939) in the glass jars in which he had kept the adult specimens. Probably they had hatched from the eggs of which he had observed some clusters e.g. on Oct. 17 1939. We could examine some of these young specimens still living; they were much darker than our animals from "de Beer", nearly brown or black; they strikingly agreed with Hancock's figures of the living *Limapontia depressa* published by Eliot (1910), as our figures of one specimen may show. This figured animal had a maximum length of 4 mm. and was more than 1 mm. broad. In this animal both genital apertures on the right side of the body, as well as the renal opening on the back, were indicated by a light patch. This, however, is an individual feature. Though a tail is figured, this character cannot be said to be constant, as this same individual later on showed the end of the back rounded. Moreover these specimens of Brakman from Zealand were different from our specimens from the island of de Beer in the position of the anus, which we found at a distance of $1/5$ — $1/4$ of the total length from the posterior extremity of the animal. If we interpret the figure of Hancock well, the position of the vent in his specimen is much more posterior, in which character it agrees with the following animals, which we identified with the var. *pellucida* Kevan. We must point, however, to the fact that Brakman's animals neither seem to be quite identical with Eliot's specimens. Yet we think the question too uncertain to justify the proposal of a new name, the more so as the study of the anatomy revealed no important differences between the animals from de Beer and of Brakman. In the animals of Brakman which had been cut in series the body was contracted so much that the position of the anus seemed again more posterior, though not so much as in the animals of de Beer.

Limapontia depressa, var. *pellucida* (Plate 2, f. c—g). The

Plate 2



a, b; *Alderia modesta* (Lovén) from the island of de Beer, a young specimen with only a few papillae, a: from above, b: from the side (both $\times 24$).
 c-g; *Limapontia depressa* Alder & Hancock, var. *pellucida* Kevan from the island of de Beer, c: from the side ($\times 24$), d: from above ($\times 24$), e: from below ($\times 9\frac{1}{2}$), f, g: from above in different positions ($\times 9\frac{1}{2}$).
 h, i; *Limapontia depressa* Alder & Hancock, var. *pellucida* Kevan, h: spawn ($\times 20$), i: part of it highly magnified.
 j-m; *Limapontia depressa* Alder & Hancock from the Northern Sloe, j, k: from above in different positions, l: from the side, m: from below (all $\times 15$).

creeping animals had a length of $2\frac{1}{2}$ —4 mm. Only in front the foot is separated from the body by a groove, which bears the mouth and on the right side below the eye the genital opening. The ground colour was light, transparent orange-yellow with many bluish white dots and strewn with fine black pigment. Sometimes this pigment is limited to the head, sometimes it is found over the whole body. The eye is situated in a pigmentless (though the white dots are found on it) oval patch, often with irregular contours behind, because here it is bordered by the dark colour of the intestine shining through. Above the heart the body is somewhat swollen and the skin is more transparent. The diverticles of the intestine are shining through the skin in a darker green. It depends on the colour and the quantity of its contents if the intestine can be seen completely from the eyes up to the anus or not. The renal organ is often (not always) visible as a white, long triangular patch shining through the skin. In the same animal it may be now clearly white, now almost invisible. The renal opening is only visible when it is opened to void its contents. The anal opening is clearly visible somewhat behind it, nearly at the hinder end of the "tail", if one may speak of a tail, for though this part of the body may be somewhat caudiform, more often it is rounded or irregular. This in contrast to *L. capitata*, which seems to possess a distinct tail. The female genital opening is not visible.

Comparison of *Limapontia capitata* and *L. depressa*.

The differences between the two species of *Limapontia*, viz. *L. capitata* and *L. depressa*, were first pointed out by Alder & Hancock 1862 in their description of *L. depressa*, later on defined more exactly by Eliot in 1910. The most exact difference seems to be the position of the anus, which in *L. capitata* is medio-dorsal, a little behind the centre of the body, while in *L. depressa* it lies nearly on the tip of the tail. The other differences are more subtle, especially as these little animals are liable to great changes of form, and,

as we have noticed by bringing the animals in weaker or stronger sea water, the same animal may look thick and round and about $1\frac{1}{2}$ times as large in a weak solution, but slender in a strong one. In the last case the head of *L. depressa* may look very much like that of *L. capitata*. The differences are more easily understood by comparing the figures of Meyer & Möbius (and others) for *L. capitata* with those of Eliot for *L. depressa*. First come the two crests above the eyes at the sides of the head, which are prominent in *L. capitata*, less so in *L. depressa*; they give the head of *L. capitata* a broader, more definite and somewhat bifurcated form. The eyes of both lie in the white areas which form the sides of the head. They seem to be situated more posterior, and usually in the posterior dorsal part of the white area in *L. capitata*; in *L. depressa*, however, the side of the head is not so flat, and the white area is smaller, oblong, with the eye more in the centre.

The second difference is the hump on the back, which may be more definite and mediodorsal in *L. capitata*, while in *L. depressa* the whole body is more flat. Here the broadest part of the body lies behind the middle. In *L. depressa* the lateral expansion is larger, because the digestive gland is more branched. These differences seem yet more prominent in *L. depressa*, var. *pellucida*. The tail finally (and this difference seems the second practical one) is longer and more acuminate in *L. capitata*, obtuse or wholly missing in *L. depressa*.

Anatomy

Alderia modesta was anatomically described by Eliot 1906 p. 376 (copied in Eliot 1910 p. 137), after Alder & Hancock had already given a figure of the radula and the penis (1851 Fam. 3, Pl. 43, f. 17—19). Comparing our sections with Eliot's description and figures we could detect differences only in the reno-pericardial system.

The renal opening lies at about $1/5$ — $1/3$ from the anterior end of the body, in the middle of the back. From there the renal organ continues forward for a small distance, ending

blindly and not continuing in a pericard. It was impossible to us to find this last organ or the heart in any of our 3 series of sections. Backward the renal sack shifts along the left side of the intestine until it lies under it. It accompanies the rectum ventrally even into the anal papilla. In this the renal tube divides into two branches, which end blindly. We found no trace of the branches into the carata mentioned by Eliot. It was obvious that the papillae had no opening to the outside, the diverticulae of the "liver" end blindly.

Limapontia capitata was observed under the compressor under the microscope by Hancock (Alder & Hancock 1848₂, p. 406—415, pl. XX). He wonders about the function of the radulasac and rightly regards the branching organ as the "liver". His opinions on the genital organs are principally in concordance with reality. Von Jhering 1877, p. 199, only describes the nervous system. The radula and penis are described by Bergh 1873, p. 207, T. XXVI, f. 18—22 and Vayssièrè 1888, p. 146—148 (also Vayssièrè 1930). Eliot 1910, p. 141, wrongly quotes Pelseener under this species.

Limapontia depressa was anatomically investigated by Pelseener 1893, p. 62, Pl. XXI. Nor our sections of *L. depressa* var. *pellucida* from de Beer, nor those of the young animals reared by Brakman show principal differences with Pelseener's descriptions. As Pelseener already states, there is a considerable variation in the size and hence in the relative position of the different internal organs, especially in those of the genital system. We did not see a renopericardial organ, nor a pore. The external renal pore lies near the tail, a little in front of the vent. It is very difficult to trace the minute, often strongly flattened tubes throughout the series, but as far as we could ascertain their interrelations, we found them to be principally the same as Pelseener figures them.

Chalidis coerulea was anatomically described as far as the technique of the time permitted by Quatrefages 1844, Pl. 4, f. IV, Pl. 5, f. VIII, Pl. 6, f. IV, VII, X, XIV, XVII.

Habitat

In the Island of De Beer the animals were found in the tide-zone in two localities. The first was the muddy bank of the Nieuwe Waterweg on the N. coast of the island, near the mole of the ferry. The mud was rather wet; one could walk on it, though with the risk of sinking in it to the ankle. Here and there small patches of *Vaucheria* stood out in the grey substance and it was on them that Geerts and Altena first found *Alderia modesta* on Aug. 24 1939. This species was again found in great quantities when Engel and Geerts revisited the place in the morning of Sept. 29. 1939. When they returned in the evening, some 6 hours later, the mud was covered by about 1 m. of water.

The second locality is situated on the other, the S. side of the island. Here the Brielsche Maas has formed "schorren" (a Dutch term introduced by Massart¹⁾ in plantsociology) only covered by water during spring tide, and "slikken" covered every tide. On the "schorren" (characteristic pictures of this type of locality are given by Gilson 1914, p. 23, f. 7; p. 64, f. 50) one finds an elaborate system of tidal creeks. In the larger branches (cf. Gilson l.c., f. 51) the water rises more than 1 m.; the smaller ones, however, are not reached before the end of the tide, when, as we observed it, the water rapidly runs up into the creeks, rising speedily and filling them in about a quarter of an hour. We could see how the specimens of *Alderia modesta* and *Limapontia depressa*, that lived here, were not taken away by the water, but stuck to the substratum, sometimes clearly with the help of a mucus-thread. The water contained 5900 mgr. Cl per L., which, according to Knudsen's hydrographical tables, corresponds with a salinity of 10,68. About 10 % of the volume of the water proved to be mud. We could not stay till the end of the tide, but it may be supposed, that the water again ebbed away after 2—4 hours, then leaving the mud uncovered (and freely accessible to sun

¹⁾ 1908, Rec. de L'Inst bot. Léo Errera, VII.

or rain) during 8—10 hours. The temperature of the water was, according to official information of the Meteorological Station, 13—14° C, both in Nieuwe Waterweg and Brielsche Maas on Sept. 29 1939.

Alderia modesta was found in most of the creeks on the patches of *Vaucheria*, some specimens also on the mud; *Limapontia depressa*, however, lived principally on the mud, not in such great numbers as *Alderia modesta*, and only in some of the creeks. *Alderia* was also found on the high banks of the larger creeks, just as Gilson (l.c., f. 51) mentions it. On 24th of August, a bright day, the animals clearly sought shelter for the sun in the shadowy side of the small holes and irregularities of the mud. *Limapontia* was especially plentiful in two rather wet places among *Phragmites* in one of the smaller creeks.

Among the other animals living on the mud of the creeks were: the Prosobranch *Assimineia grayana* Fleming and the Isopod *Sphaeroma rugicauda* Leach, which latter briskly swam round as soon as the tide came up. Further we found in the water the Gammarids *Orchestia gammarellus* (Pall.) and *Corophium volutator* (Pall.), a large number of young *Carcinides moenas* (L.) (breadth of carapax 5—10 mm.) and *Gobius microps* Krøyer. In the mud millions of specimens of the Oligochaets *Pachydrilus lineatus* (Müller) and *Tubifex costatus* (Clap.) and a Polychaet: *Manayunkia aestuarina* Bourne lived and here also the typical brackish water Harpacticids (Copepoda) *Platychelipus littoralis* Brady and *Nannopus palustris* Brady were found.

The small pools on the N. side of De Beer contained the Hydroid *Laomedea gelatinosa* (Pall.).

The animals in captivity

Twenty *Alderia modesta* from "de Beer" were kept for about a fortnight on *Vaucheria* and mud from their habitat. Every morning a quantity of water, obtained by diluting the Amsterdam Aquarium water from a salinity of 36,96 to S.

10,26 was thrown over them and after some time removed again. Geerts for some other specimens managed to imitate the tides as on the original habitat, covering the mud with brackish water twice a day for a couple of hours. While *Alderia modesta* would try to creep out when kept under water, *Limapontia* thrived well in it, dying soon, however, when kept on wet mud only. *Alderia* showed much less resistance than *Limapontia*. Sometimes *Limapontia* crept against the surface of the water in the usual way; the foot appearing dry, though slimy. We only had 4 specimens of *Limapontia depressa*, var. *pellucida*, two of which soon died, while the other two lived for more than three weeks in captivity under water, in spite of the experiments with other salinities described below. On Nov. 10 1939 we received from Mr. Brakman a number of living specimens of the typical species, which had probably come out of the eggs in his glass jars with algae. Some were used for the experiments, these are still living (April 1940).

Alderia is fixed to the substratum by means of a thin layer of slime. When at ease it rhythmically contracts the papillae, successively left and right, one side contracting while the other swells again. Though this is the principle, it must be understood that not all the papillae are always active, nor are they all alike in their activity. Sometimes one papilla may remain inactive; only one row may work, sometimes only two. In *Limapontia* the beating of the heart can sometimes be seen through the skin. Though a heart could not be found in our sections of *Alderia*, here also a beating movement was sometimes observed in the anterior region of the back. Both species easily turn round, when they fall on their back.

While creeping both make tentative movements with the margins of the foot and of the head. The very sensitive contractile skin is in constant movement and consequently changes the form of the animal, especially in *Limapontia*. Though it was often looked for, feeding was never observed. To the naked eye it may seem that the animals are eating the algae, but

magnification only reveals tentative movements along the algae-threads.

The euryhalinity

It may be supposed that animals living in the described conditions must belong to very eurytopical species. They must stand the salinity of the tide, which cannot always be the same, the drying action of the sun and wind, and the sudden change in salinity when it rains. Some experiments were made to see how wide the range of salinity (S.) was, which they could bear. As stated above they were found in water of S. about 10 (i.e. a salinity of 10 gr. salt per L.).

The experiments showed that the animals can bear a change of salinity from S. 10 up to S. 37 and perhaps higher, and down to about S. 2 (individually different: *L. depressa*, var. *pellucida* died in S. 0 and collapsed in S. 1, *L. depressa typica*, however, stayed two days in S. 1 and a night in S. 0,75, one *Alderia modesta* could not bear S. 3, another S. 2, while a third animal in S. 1 only extruded its penis).

Slow changes (e.g. a quarter of an hour successively in S. 12, 14, 16, etc.) are easily borne. To sudden changes from S. 10 in S. 37 or in S. 2, or even from S. 37 in S. 2 the animal reacts convulsively, swelling when the salinity is lessened and becoming thinner in higher salinities (in these *L. depressa* even assumes some of the characters of *L. capitata*, especially its clear cut form, though always yet differing from it in the posterior position of the anus and the more obtuse tail). After a sudden change the animals may lie on the bottom of the basin for some minutes, but they usually recover after a quarter of an hour, creeping actively again, though they remain leaner resp. more swollen. To the convulsive reaction are often added slime secretion, defecation and oviposition and in *A. modesta* contraction of some papillae to narrow tubes, while others unnaturally blow up, the pulsations becoming irregular. A less convulsive reaction consists in tentative movements of the head and each time a shrinking back and seeking again in

another direction. In high concentration the hump on the back of *Limapontia* often is very conspicuous, while the heart is clearly seen beating vigorously (usually invisible). The renal organ, visible as a lighter triangular patch on the back in this species, becomes more visible, more white, and its opening is distinct. It was seen that one animal voided a whitish flocky substance from this opening. The animals may also creep against the surface of the water, if the salinity is too high.

One *Alderia* was put into aqua dest. + 1 % of chloroform; the animal contracts, defecates and the contents of the papillae, a green substance, pour forth from their top. Though it might be assumed that the animals bear pores at the tops of the papillae, sections show that this is not the case.

We remarked wide individual differences in resistency and adaptability and curious enough we got the impression that in both species the animals became accustomed to the changing of the salinity, reacting more easily and less convulsively as the experiments proceeded.

When, by putting a quantity of sea-salt on one side of a basin with distilled water, a scale of salinities was offered, the animals neither from the brine nor from the fresh side moved to a certain concentration. It was also tried whether the animals sought the light if they were put into a basin wholly covered with black paper, only a small slit, 5 mm. broad and 80 mm. high, being left open. Sometimes it was tried with a lamp, sometimes with common daylight, but the animals did not gather in the light, nor was it possible to say that they shunned it.

Reproduction

The spawn of *Alderia modesta* has been figured by Alder & Hancock 1852, Fam. 3, Pl. 41, f. 4, 5, and by Nyst 1855, f. 2, while Schulze 1936, p. 43 seq. described the early development and figured a larva.

The spawn of *Limapontia capitata* can be found in Alder & Hancock 18482, Pl. XIX, f. 7 (larva f. 8), in Meyer

& Möbius 1865, f. 9, and in Vayssière 1903, Pl. II, f. 21. The first cleavage stages were figured by Müller 1848; Si 1931, p. 137, has given good figures (f. 62, 63) of the animal while depositing its eggs, and of the spawn, showing the difference between the first and the second spawn; though he got the veliger (l.c. p. 199) he gives no details.

We observed two *Limapontia depressa*, var. *pellucida* in copulation while we saw another that had pricked its penisthorn somewhere in the body, but not in the genital opening of its partner. The same was remarked by Adam & Leloup 1939, p. 7 for *Alderia*.

In Amsterdam both species spawned. It is impossible to distinguish the spawn specifically; in both species it can be short, nearly oval, but generally it is longer, about equal to the body length, and cylindrical. It is fastened at one end. The eggs are arranged in an irregular spiral.

Limapontia depressa, var. *pellucida* spawned in the night of Oct. 6—7 (Pl. 2, f. *h, i*), on Oct. 7 the eggs showed blastulae, on Oct. 8 gastrulae.

In the eggs of *Alderia modesta* laid Oct. 4 we found gastrulae on Oct. 6 and larvae moving in the egg case on Oct. 7, but also on Oct. 11. On the 12th of October one veliger was free.

The specimens of *Alderia modesta* that Geerts kept living also laid eggs. These were deposited by preference on the elevations of the mud and *Vaucheria*, and not in the depressions. Some animals were even observed to spawn in an absolutely dry place, even on the sides of the terrarium. The spawning animal first fastened the beginning of its spawn on *Vaucheria* or some other more or less solid material, and then it looked as if the outpouring of the egg string forced the animal backwards, it sometimes even "stood" on its tail. Other specimens, probably less absorbed in the act of spawning, simply crept forward while the eggs protruded from the genital opening. The spawn was sometimes an irregularly waved string, sometimes, however, a rather small and imperfect patch.

The chain of ova in the gelatinous envelope always more or less spirally coiled, the eggs themselves first of an orange to dark yellow colour, soon, however, becoming a dirty yellow. One animal after spawning was followed by another, with the penis half extruded; they turned some times round each other, but then parted. Two others were observed in copula.

After 3 days 20 % of the ova had divided and consisted of 2 cells, the rest yet showed 1 cell. After 5 days most eggs contained 4 cells, only 2 % showing 1 or 2 cells. Of another set the eggs showed already blastulae after 5—6 days, while others then contained 16, 8, or 4 cells.

Brakman found Nov. 1 young *Limapontia depressa* of different sizes in three glasses with algae, which he had collected in the beginning of September. Obviously these had hatched from the eggs of animals he discovered while spawning in his jars on the 1st of October. We got some of these young animals; the largest was figured on the 9th of December (Pl. 2, f. *j—m*), then measuring about 4 mm., the others were 3—4 mm. then.

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