

dark or brownish-grey, densely studded with minute papillæ; speckled with black, angular or irregular maculæ; a yellow mesial line down the back; margins edged with a yellowish or pale band; superior pair of horns hyaline, the buccal pair yellowish-grey.

The body never makes any approach to linear even when most extended; it is always rather broad, and fully rounded posteriorly, less so at the anterior extremity. There is no defined margin separating the central part from the edges; the latter are merely a little flatter: there is not the least trace of solid material in the covering or in the substance of the body. The superior pair of horns are cylindrical, somewhat longish, and terminate in a little rounded bulb, on the upper surface of which the minute black eye is imbedded; the buccal pair is bilobed, but not deeply sulcated, appearing exactly as if two short cylinders were under a skin. The foot terminates a little before the end of the mantle; it occupies in breadth about one-fifth or rather more of the under surface, and is separated by a deep groove from the mantle, so that it appears as if winged: it has about 200 transverse rugæ in the inch, which, in the advancing movement of the animal, present precisely the same appearance as the legs of *Julus*, a wave running from behind forward, about six rugæ forming each wave, with an interval of fourteen to eighteen between them. The under surface of the body of the animal on each side of the foot is covered with minute papillæ or tubercles, about 180 in an inch.

The habits of the animal, as far as I had an opportunity of examining them, appear to differ in no respect from those of *Limax*.

EXPLANATION OF PLATE II. B.

Fig. 1. *Vaginula maculata*.

Fig. 2. Ocular tentacle.

Fig. 3. Section of buccal tentacle.

Fig. 4. Transverse sections of body.

Fig. 5. Lower surface of body and foot.

Fig. 6. *Vaginula* —?

VIII.—On the Occurrence of Marine Animal Forms in Fresh Water. By Dr. E. VON MARTENS*.

THE genera *Sphæroma* and *Palæmon*, *Gobius* and *Blennius* occur plentifully in the North Sea, but are entirely unknown in the

[* Translated by W. S. Dallas, F.L.S., from Wiegmann's Archiv, 1857, p. 188. This paper forms the third section of a long memoir "On some

fresh waters of Northern and Central Europe. That, on the contrary, several species of *Blennius* occur in the fresh waters of Southern Europe, has been already observed; the family of the *Gobioidei* includes numerous East Indian freshwater fishes, several belonging to the genus *Gobius* itself. As regards *Palæmon*, a freshwater crustacean ('Camaron de agua dulce,' *Palæmon Jamaicensis*, A.) of Jamaica and Cuba has been known since the time of Sloane and Parra; and, according to an oral statement of Dr. Engelmann, a species of this genus (still undescribed?) lives near St. Louis in N. America. To the same family belong the Sicilian *Symethus fluviatilis* of Rafinesque, which, although so imperfectly described and again denied, rests upon some observation, and also the *Hippolyte Desmarestii* of Millet, discovered some time since in the Mayenne, the Sarthe and other rivers of the north-west of France*; Dana's Chilian freshwater crustacean, *Cryphiops spinulosomanus*; and lastly, the pale, eye-less Cavern Shrimp (*Troglocaris*) of the Adelsberg caves. Associated with the latter is the recently-discovered *Monolistra*; this has hitherto been the sole known freshwater representative of the *Isopodes nageurs* of Milne-Edwards (*Cymothoidea*, Dana), to which *Sphæroma* belongs.

Several families also, which, even in the region of the Mediterranean as in the North Sea, are purely marine,—of which the most remarkable examples are the *Scomberoidea*, and Sharks and Rays,—are represented in tropical regions by freshwater forms (*Mono-cirrhus polyacanthus*, Heckel, in the Rio Negro; *Carcharias gangeticus*, Müll. & Henle, sixty leagues above the sea; *Pristis Perroteti*, Müll. & Henle, in the Senegal; *Raia fluviatilis*, Ham.-Buch., near Kampur, 1000 English miles above the influence of the tide; and the *Trygon* discovered by Schomburgk in the River Magdalena). The entire section of the Brachyurous

Fishes and Crustacea of the Italian Fresh Waters," the occurrence of a Blenny in which was pointed out by Pollini as long ago as 1816. The most important species observed by the author were—

Atherina lacustris, Bonap.

Blennius vulgaris, Pollini.

Gobius fluviatilis, Bonelli.

Leuciscus alburnellus, Filippi.

Leuciscus Savignyi, Val.

Alosa finta, Troschel.

Palæmon lacustris, n. sp., in the Lake of Albano.

Sphæroma fossarum, n. sp., in the Pontine Marshes.

These species are all described in the second part of his memoir, and both this and the first part contain remarks upon other animals inhabiting the fresh waters of the South of Europe, which belong to what are generally regarded as marine groups.—TRANSL.]

* Ann. Sci. Nat. xxv. pl. 10. fig. B. 1832.

Crabs, existing in the sea as far as Greenland and Spitzbergen, is only represented in the fresh water in the subtropical climates by one *Thelphusa*, and rises in the West Indies by the *Gecarcinus* to a permanent dwelling on land. Amongst the bivalve Mollusca, *Arca scaphula*, Benson, lives in the Jumna near Humerpoor, at a distance of 1000 English miles from the sea, and *Pholas rivicola*, Sow., in the fresh water of the river Pantai, twelve English miles above its mouth, in floating wood. Thus our usual notion of the distribution of marine and freshwater animals in different families, derived from the circumstances of our native country, is more and more modified with the advance of knowledge, and it becomes a question which of the numerous families of aquatic animals are exclusively proper to one of the two media, and how far the dwelling-place is in accordance with the systematic position, that is to say, with the modifications of organization,—a question which is of peculiar geological interest. To arrive at a result which shall not be entirely negative, it will be advisable to pay no regard at all to the multifarious mixtures and points of transition between the two elements, such as are presented on a small scale by the mouths of rivers and saline lakes, and on a large scale by the Baltic and Caspian Seas, and to confine ourselves solely to the contrast of rivers and inland lakes with the open sea. We must also disregard the distinction of the families whose species all live in the sea, and of which some only ascend temporarily into the fresh water (such as *Alosa*), from those which possess a few constant representatives in the latter medium (e. g. *Lota*), as with regard to many, and some of these the most interesting of the exotic river-fish, we do not know whether they are migratory or stationary. With these limitations, and the still more important ones of our present knowledge, the following Table furnishes a summary of the freshwater animals amongst the Fishes, Crustacea and Mollusca, according to families and climatic zones, especially for the Old World, in which, however, those occurring only in the other hemisphere are inserted, with the corresponding indication, N. Am., S. Am., or Austr. (North America, South America, Australia). With regard to its freshwater animals, Iceland is related to the countries of the high northern latitudes; Central Europe is considered to extend southwards to the principal range of the Alps; Egypt and Syria (on account of *Mastacemblus*) are referred to the torrid zone.

o. Indicates that the family does not occur in this zone.

m. Indicates that the family only occurs in the sea in this zone.

— Indicates that the family occurs both in the sea and in fresh water in this zone.

†. Indicates that the family only occurs in fresh water in this zone.

The parentheses indicate rare, or rather occasional occurrence. The families printed in italics are exclusively inhabitants of fresh water.

		I.	II.	III.	IV.	V.
		Greenland and Iceland.	Scandinavia.	Central Europe.	Southern Europe.	Torrid zone.
Pisces.						
DIPNOI	<i>Sirenoidei</i>	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	†
	Percoidei	<i>o</i>	—	—	—	—
	Cataphracti	—	—	—	—	<i>m</i> ¹
	Sciænoidei	<i>o</i>	(<i>m</i>)	<i>m</i>	<i>m</i>	—
				(N. Am. Austr.)		
ACANTHOPTERI	<i>Labyrinthici</i> ...	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	†
	Mugiloidei	<i>o</i>	<i>m</i>	<i>m</i>	<i>m</i> ²	—
	Atherinoidei ...	<i>o</i>	<i>o</i>	<i>m</i>	—	<i>m</i>
	Notacanthini ³ ...	<i>m</i>	<i>o</i>	<i>o</i>	<i>o</i>	— [?]
	Scomberoidei ...	<i>m</i>	<i>m</i>	<i>m</i>	<i>m</i>	— ⁴
	Blennioidei	<i>m</i>	<i>m</i>	<i>m</i>	—	<i>m</i> [?]
	Gobioidei	<i>m</i>	<i>m</i>	<i>m</i>	—	—
ANACANTHINI	Gadini	<i>m</i>	—	—	—	<i>o</i> [?]
	Pleuronectidi ⁵ ...	<i>m</i>	—	—	—	<i>m</i> [?]
PHARYNGOGNATHI	<i>Chromides</i>	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	†
	<i>Scomberesoces</i> ..	<i>o</i>	<i>m</i>	<i>m</i>	<i>m</i>	— ⁶
	<i>Siluroides</i>	<i>o</i>	<i>o</i>	†	<i>o</i>	— ^{6b}
				(N. Am.)	(N. Am.)	
	<i>Loricariæ</i>	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	†
	<i>Cyprinoidei</i>	<i>o</i>	†	†	†	†
	<i>Characini</i>	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	†
	<i>Cyprinodontes</i> ...	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	†
	<i>Mormyri</i>	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	†
	<i>Esoces</i>	<i>o</i>	†	†	†	<i>o</i>
PHYSOSTOMI	<i>Galaxiæ</i>	<i>o</i>	S. Am. †	Austr. †	<i>o</i>	<i>o</i>
	Salmones	—	—	—	†	<i>o</i>
	Clupeoidei	<i>m</i>	<i>m</i> [?]	—	—	—
	<i>Hyodontes</i> , Val... <i>Elopes</i> , Val.....	<i>o</i>	<i>o</i>	N. Am. †	N. Am. †	†
	<i>Heteropygii</i>	<i>o</i>	<i>o</i>	N. Am. †	<i>o</i>	<i>o</i>
	Murænoidei	—	—	—	—	—
	<i>Gymnotini</i>	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	†
	<i>Symbranchii</i> ...	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	—
PLECTOGNATHI	<i>Gymnodontes</i> ...	<i>o</i>	(<i>m</i>)	(<i>m</i>)	<i>m</i>	— ⁷
LOPHOBRANCHII	<i>Lophobranchii</i> ...	<i>o</i>	<i>m</i>	<i>m</i>	<i>m</i>	— ⁸
	<i>Polypterini</i>	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	†
	<i>Lepidosteini</i>	<i>o</i>	<i>o</i>	<i>o</i>	N. Am. †	Am. †
GANOIDEI	<i>Amiæ</i>	<i>o</i>	<i>o</i>	<i>o</i>	N. Am. †	<i>o</i>
	<i>Acipenserini</i> ...	<i>m</i>	—	—	—	<i>o</i> [?]
	<i>Spatulariæ</i>	<i>o</i>	<i>o</i>	<i>o</i>	N. Am. †	<i>o</i>
PLAGIOSTOMI	<i>Squali</i>	<i>m</i>	<i>m</i>	<i>m</i>	<i>m</i>	— ⁴
	<i>Rajæ</i>	<i>m</i>	<i>m</i>	<i>m</i>	<i>m</i>	— ⁴
CYCLOSTOMI	<i>Petromyzones</i> ...	<i>m</i>	—	—	—	?

		I. Green- land and Iceland.	II. Scandi- navia.	III. Central Europe.	IV. Southern Europe.	V. Torrid zone.
Crustacea⁹.						
PODOPHTHALMA ...	Brachyura in general.	<i>m</i>	<i>m</i>	<i>m</i>	—	—
	<i>Thelphusina</i>	<i>o</i>	<i>o</i>	<i>o</i>	†	†
	Astacidea.....	<i>o</i> ⁹	—	—	—	—
	Caridea	<i>m</i>	<i>m</i>	—	—	—
TETRADECAPODA..	Idoteidea.....	<i>m</i>	<i>m</i>	<i>m</i>	(S.Am. ¹⁰)	<i>m</i>
	Oniscidea.....	— ¹¹	—	—	—	<i>m</i> ?
	Cymothoidea	<i>m</i>	<i>m</i>	<i>m</i>	—	<i>m</i> ?
	Gammaridea	—	—	—	—	—?
	Cyclopoidea.....	<i>m</i> ?	—	—	—	—
GNATHOSTOMA ...	<i>Daphnoidea</i>	†	†	†	†	†
	Cyproidea	—	—	—	—	—
	Artemioidea.....	<i>o</i>	—	†	†	† ¹²
	Apodoidea	—	—	—	†	†
	<i>Limnadioidea</i>	<i>o</i>	—	†	—	†
CORMOSTOMA.....	Caligoidea	<i>m</i>	<i>m</i>	—	?	—
	Lernæoidea	<i>m</i>	—	—	—?	—
Mollusca.						
GASTEROPODA	<i>Melaniacea</i> ¹³	<i>o</i>	<i>o</i>	†	†	†
	<i>Paludinacea</i> ¹³	†?	†	†	†	†
CTENOBRANCHIA.	Neritacea.....	<i>o</i>	†	†	—	—
GASTEROPODA	<i>Limnæacea</i>	†	†	†	†	†
	<i>Ampullariacea</i>	<i>o</i>	<i>o</i>	<i>o</i>	N. Am.†	†
PULMONATA.	Mytilacea.....	<i>m</i>	<i>m</i>	—	—	—
	Arcacea	<i>m</i>	<i>m</i>	<i>m</i>	<i>m</i>	— ⁴
CONCHIFERA	<i>Najadea</i>	<i>o</i>	†	†	†	†
	<i>Cycladea</i>	†	†	†	†	†
	Tellinea	<i>m</i>	<i>m</i>	<i>m</i>	<i>m</i>	— ¹⁴
	Solenacea.....	<i>o</i>	<i>m</i>	<i>m</i>	<i>m</i>	— ¹⁵
	Pholadea	<i>o</i>	<i>m</i>	<i>m</i>	<i>m</i>	— ⁴

Remarks.

1. Tropical species of *Gasterosteus* or *Cottus* are unknown to me.
2. Schmarda (Geogr. Verbreitung der Thiere, p. 59) speaks of Sea Mulletts in the pond near Arcach; this is unknown to me. In a lake near Arquà (not far from Padua), sea fishes are to be found according to a popular tradition. Species of *Mugil* are often kept in Italy in brackish water ponds, and in France they ascend the rivers in abundance (see Valenciennes), but I do not know how far they go into pure fresh water. In tropical countries, *Mugil liga*, *Nestis*, and *Dajaus* occur in fresh water.
3. *Campylodon* in the Greenland Sea; *Mastacemblus* in Indian rivers and even near Aleppo (Russell).
4. See p. 51.
5. *Platessa flesus*, according to Nilsson, ascends in Sweden as far as the peat moors of Jaeravallen, and probably in the Rhine as far as Bonn, as Dr. Günther has had the kindness to inform me from the statements of fishermen. The nearly allied *Passara* (*Pl. passer*, Bp.) ascends the Po even into the small rivers Tar-

taro and *Molinella*, as was indicated by Pollini (Viaggio al Lago di Garda, p. 22). With regard to *Pl. limanda* and *Pl. Solea*, consult Schmarda (*op. cit.* p. 148). I do not know whether ascending species also occur in the torrid zone; but according to Hamilton-Buchanan, some species are abundant in the brackish water of the Ganges, up which they pass as far as the tide reaches.

6. *Belone cancila*, Ham.-Buch., and *caudimacula*, Val., in the East Indies. According to Professor Peters, *Hemiramphus far*, Rüpp., ascends the rivers in Mozambique.

6 b. *Galeichthys marinus*, Mitchill (*Parræ*, Val.), of Cuba and New York, *G. feliceps* of the Cape, and *Plotosus lineatus*, Val., found from the Red Sea to the Friendly Islands, are sea fishes.

7. *Tetrodon fahaca*, Forsk., in the Nile; other species in the Ganges.

8. *Syngnathus deocata*, Ham.-Buch., in the Kowarlayi river in Northern Bengal; *S. Zambesensis* and *Argulus*, Peters, in Mozambique.

9. Of the distribution of the marine Crustacea Dana has given a most copious summary at the conclusion of his great work, of which I have availed myself with pleasure; his frigid zone corresponds with my No. I., subfrigid with II., cold temperate and subtemperate, III., temperate (the Mediterranean Sea) and warm temperate, IV., subtorrid and torrid, V.

10. *Chaetilia ovata*, Dana, from Chili, is a freshwater species.

11. *Jaera*, Leach, a marine genus of the subdivision *Asellidæ*, the species of which occur from Greenland to the warm temperate zone. The occurrence of the *Asellus* in Greenland is doubtful; Fabricius himself did not see it. Nothing belonging to this subdivision is known from the tropics.

12. The Brine Shrimps (*Artemia*) are certainly not freshwater animals, nor do they live in the sea. The other members of this division are freshwater animals (for example *Branchipus*).

13. In this case I follow Woodward's division, according to which the spiral operculum constitutes the distinction between the two families—(by this, *Hydrobia*, Hartm. and *Lithoglyphus*, Mhlfld. must be referred to the *Melaniacea*)—but I think that their separation from the *Littorinida* is scarcely admissible, and that it was only tried on account of the difference of habitation. Such a wide separation of the smooth *Rissoæ* (*Paludinella*, Lovén, Beck) from *Hydrobia*, Hartm. (*Amnicola*, Haldeman, *Paludinella*, J. C. Schmidt) especially cannot be allowed.

14. Here, according to Woodward, the African *Galathea*. The *Ætheriæ* are referred by him to the *Najadea*.

15. *Novaculina gangetica*, Bens., perhaps only in brackish water, like *Potamomya* (Corbulacea) and *Gnathodon* (Mactracea).

The following considerations arise out of this Table:—

A. If we add for each zone the marine families occurring

therein (taking for the Crustacea only Dana's higher divisions in *-inea* or *-oidea*, and not the families in *-ida*, in order to avoid too minute a division), the number of families appears to be:—

	Exclusively in Sea.	Fresh water.	Common to both.	Total.
Fishes	16	16	23	55
Crustacea	29	3	10	44
Mollusca*	40	6	6	52

Thus the number of the freshwater and marine forms is equal only for the Fishes; and even here, if we divide the Plagiostomi, which were referred to for the sake of the general view only as *Rajæ* and *Squali*, into J. Müller's 16 or 21 families, of which only 4 occur also in fresh water, the marine species acquire a preponderance.

According to the zones they are distributed as follows:—

	a. Common forms.	b. Exclusively Marine.	Freshwater.	Proportion of a to b.
I. Cold Zone.				
Fishes	3	15	0	1:5
Crustacea.....	3	17	1	1:6
Mollusca	0	27	3	1:8
II. Cold Temperate Zone.				
Fishes	8	19	2	1:2 $\frac{5}{8}$
Crustacea.....	7	24	1	1:3 $\frac{4}{7}$
Mollusca	0	34	5	1:∞
III. Middle Temperate Zone.				
Fishes	11	18	4	1:2
Crustacea.....	8	28	3	1:3 $\frac{7}{8}$
Mollusca	1	39	6	1:45
IV. Warm Temperate Zone.				
Fishes	11	19	7	1:2 $\frac{4}{11}$
Crustacea.....	9	25	4	1:3 $\frac{2}{9}$
Mollusca	2	43	6	1:24 $\frac{1}{2}$
V. Torrid Zone.				
Fishes	16	21	11	1:2
Crustacea.....	5?	26	5	1:6 $\frac{1}{5}$?
Mollusca	6	40	6	1:7 $\frac{2}{3}$

We see, consequently, that from the cold to the torrid zone there is an increase of the common families; the exception of the Crustacea in the torrid zone may only be apparent, and due to our imperfect knowledge of the tropical freshwater animals. This increase is not only an absolute one, such as is shown also by the exclusively marine and freshwater families, and such as was to have been expected, but a relative one, at the expense of

[* The term *Mollusca* here and in the following Tables is used for brevity to signify the *Gasteropoda* and *Conchifera* alone, these being the only classes of Mollusca represented in both salt and fresh water.]

the exclusive families. The common families form a greater portion of the total number of families represented in that zone.

B. But even the number of the exclusively freshwater families increases in proportion to those which occur also in the sea, or only in salt water, from the cold to the torrid zone; this is very decidedly the case with the Fishes (I. 1 : ∞ ; II. 1 : $13\frac{1}{2}$; III. 1 : $9\frac{3}{4}$; IV. 1 : $4\frac{2}{7}$; V. 1 : $3\frac{4}{11}$), but also distinctly with the Mollusca (I. 1 : 9; II. 1 : $6\frac{4}{5}$; III. 1 : $6\frac{2}{3}$; IV. 1 : $7\frac{1}{2}$) and with the Crustacea (I. 1 : 20; III. 1 : 12; IV. 1 : $8\frac{1}{2}$; V. 1 : $6\frac{1}{3}$).

C. In the same way also the number of families occurring in the fresh water generally, increases in proportion to that of those occurring generally in the sea; thus in

	I.	II.	III.	IV.	V.
Fishes.....	1 : 6	1 : $3\frac{9}{10}$	1 : 2	1 : $1\frac{2}{3}$	1 : $1\frac{1}{3}$
Crustacea ...	1 : 5	1 : $3\frac{7}{8}$	1 : $3\frac{3}{11}$	1 : $2\frac{11}{13}$?	1 : $3\frac{1}{10}$
Mollusca.....	1 : 9	1 : $6\frac{1}{5}$	1 : $5\frac{5}{7}$	1 : $5\frac{5}{8}$	1 : $3\frac{5}{6}$

Here again also the tropical freshwater Crustacea constitute the sole exception, probably in consequence of deficient information. This increase, like that under B, is the confirmation of a general law, which has already been expressed as follows:—Towards the poles, organic life retreats from the severe climate of the land to the more temperate climate of the ocean: where, as in Greenland*, the entire interior of the country is a permanent mass of ice, and the alternation of thaw and frost only occurs on the coasts and bays, the freshwater fauna will not be very rich.

D. Of the freshwater families those which are exclusively peculiar to this medium, are in proportion to those common to it and the sea in

	I.	II.	III.	IV.	V.
Fishes.....	1 : ∞	1 : 4	1 : $2\frac{3}{4}$	1 : $1\frac{4}{7}$	1 : $1\frac{1}{3}$
Crustacea ...	1 : 3	(1 : 7)	1 : $2\frac{2}{3}$	1 : $2\frac{1}{4}$	1 : 1?
Mollusca ...	1 : 0	1 : 0	1 : $\frac{1}{6}$	1 : $\frac{1}{3}$	1 : 1

Here, therefore, there is a remarkable contrast between Fishes and Mollusca; in the former the common families everywhere predominate over the exclusive ones (although not in number of species), but this preponderance diminishes constantly and considerably from the cold zone, where it finds no balance, to the equator; in the Mollusca the common families never predominate over the exclusive ones, but their proportion to the latter increases in the same direction from 0 to equality; in both classes, therefore, a progressive equalization takes place towards the equator, but towards the poles a divergence in

* See Rink, Grönland geographisk og statistisk beskrevet. Kjöbenhavn, 1857.

opposite directions, as here, amongst the Fishes the common *Salmones*, and amongst the Mollusca the exclusively freshwater *Limnææ* and *Pisidia* prevail, the former protected from the frost by their migrations, and the latter by their hibernation.

E. There are families which are common to both media in one zone and peculiar to one of them in another; of the four cases possible here, we have in the

	Fishes.	Crustacea.	Mollusca.
a. Exclusively marine in a colder zone than that in which they are common	17	6	5
b. Exclusively freshwater in the cold zone.....			
c. Exclusively marine in the warmer zone	5	2	
d. Exclusively in fresh water in the warmer zone		1	

Of these the deficiency of the *Blennioidei*, *Pleuronectidei* and *Apodoidei*, and perhaps also that of the *Atherinæ*, *Idoteidea* and *Cymothoidea* in the fresh waters of the tropical zones, as well as that of the *Sciænoidea* in the subtropical, and of the *Lernæoidea* and *Cyclopoidea* in the cold zone, may be due solely to the deficiency of our information, by which in *a* 2, and in *c* and *d* all the examples would be cancelled. For *b*, the Silure in the Old World furnishes a striking instance; but in America there is in the same zone a marine Silure (*Galeichthys marinus*, Mitch.). The *Siluroidei*, and perhaps also *Petromyzon*, present the only examples of families living especially in fresh water with individual representatives in the sea; the other common families generally exhibit the opposite relation.

Of the families included under *a*, the following first make their appearance in the particular zones in

	II.	III.	IV.	V.
Of the Fishes.....	4	2	3	8
Of the Crustacea	3	2	1	
Of the Mollusca		1	2	3

This phænomenon is therefore most remarkable and regular amongst the Fishes (*Gadini*, *Clupeoidei*, *Blennioidei*, *Lophobranchii*); amongst Crustacea, according to our present knowledge, it makes its appearance distinctly even in the temperate zone (*Caridea*, *Idoteidea*, *Cymothoidea*), but amongst the Mollusca only in the tropical zone: that it exhibits the greatest number of examples in Zones II. and V., is probably because II. to IV. are merely subdivisions of the one temperate zone, so that only II. and V. mark the occurrence of a new principal zone.

From this we may formulate the following propositions for the above-mentioned four classes:—

1. The majority of the family-forms, both generally and in each zone, belong exclusively to one of the two media (A).

2. The inhabitants of the fresh water generally and in each zone are more uniform (and less numerous) than the inhabitants of the sea (C).

3. The inhabitants of fresh water increase from the pole towards the equator, not only absolutely, but also relatively in proportion to the inhabitants of the sea, in multiplicity of forms (and in number) (C).

4. This increase depends not only upon the development of new peculiar forms, but also upon participation in the marine forms (D).

5. The similarity of the individual freshwater animals to individual marine animals decreases from the pole towards the equator (B).

6. The similarity of the total freshwater fauna to the total marine fauna increases from the pole towards the equator (A).

The apparent contradiction of the two preceding propositions is explained by the fact that in the fifth the exclusively marine families are not taken into consideration at all, but that in the sixth they, as well as the exclusively freshwater forms, form the negative factor.

7. Numerous family-forms are exclusively marine in colder regions; in warmer regions (still principally marine, but) also represented (by individual species) in the fresh water (E).

Here especially belong those animals which led to the preparation of the present memoir.

The above propositions of course only apply so far as the families adopted as the foundation for the calculation within each class may be regarded as equivalent with respect to the similarity of their structure. Advances in systematic zoology, therefore, as well as in the knowledge of faunas, which is still so very deficient, especially for the tropical regions, may modify them. A comparison of the three classes amongst themselves, according to which the similarity between the Molluscos fauna of the sea and of the fresh water in each zone is less than that of the Crustacea, and this less than that of the Fishes, would also at the same time presuppose the equivalence of the divisions adopted in all the four classes, which however will remain a matter of individual opinion. Thus, had I adopted as a foundation for the Crustacea, the numerous subdivisions which Dana calls families, the numbers for the freshwater species would have proved but little greater, whilst those for the marine forms would have been considerably higher, because amongst these subdivisions also the marine animals again predominate; within each separate zone, therefore, the relative number of the inhabitants

of fresh water to those of the sea would have become smaller, but the increase or decrease according to the zones would not have changed, or only unessentially. If we advance to the higher steps of classification, the numerical agreement between the two media constantly becomes greater, but the differences which still remain are of a more essential nature. This is the case even in the consideration of the orders:—Of the fourteen which J. Müller has adopted for the class of Fishes, only five, and these very poor in species (with 1—3 genera, and not many more species), are limited to one of the two media,—the *Sirenoidei* and *Ganoidei holostei* to fresh water, and the *Holocephali* (*Chimara*), *Hyperotreti* (*Myxine*), and *Leptocardii* (*Amphioxus*) to the sea*.

Amongst Dana's larger sections of the Crustacea, one-half (seven) in number are certainly peculiar to the sea:—*Anomura*, *Stomapoda*, *Schizopoda*, *Aploopoda*, *Anisopoda*, *Merostoma*, *Cirripedia*, but these are all poor in species; not one is peculiar to the fresh water; and of the three principal sections, *Podophthalma*, *Edriophthalma* and *Cirripedia*, two are common. In the *Annelida*, on the contrary, we find not only that the majority of the orders (three to two, according to Grube) are exclusively marine, but also that these are by far the most developed and most numerous. In the *Gasteropoda* also, the exclusively marine orders predominate, and hold the balance against the common and freshwater orders together; thus, according to Troschel's classification, there are five orders, *Heteropoda*, *Cyclobranchiata*, *Notobranchiata*, *Monopleurobranchiata*, and *Hypobranchiata*, against the two common orders, *Ctenobranchiata* and *Rhipidoglossata*, together with the entirely non-marine *Pulmonata* and *Pulmonata operculata* (Troschel, however, excludes the *Heteropoda*); in the more recent English systems, especially in Woodward's, we have the two marine orders, *Nucleobranchiata* and *Opisthobranchiata*, against the common *Prosobranchiata* and the non-marine *Pulmonifera*, but still of the two most numerous orders, the one always includes the common, and the other the non-marine forms (disregarding the *Auriculæ*, *Onchidiæ* and *Amphibola*, which dwell upon the borders). An essential difference for the orders, according to the zones only, occurs with the Fishes, the two exclusively belonging to the freshwater (*Sirenoidei*, *Ganoidei holostei*), being those which are wanting in the colder regions; amongst the *Gasteropoda* the colder zones are destitute both of the marine *Heteropoda* (*Nucleobranchiata*) and of the non-marine *Operculated Pulmonata*, and amongst the *Crustacea*

* The Berlin Museum has received an *Amphioxus* from Ceylon, from M. Nietner. It is unfortunately not well preserved.

only the scanty division of the Merostoma (*Limulus*), the most northern of which occurs near Boston.

Of the essentially aquatic classes (or subclasses, according to the differences of system) of animals, we find that eleven, namely the Polycystineæ, Anthozoa, Acalephæ, Ctenophora, Siphonophora, Echinodermata, Tunicata, Brachiopoda, Pteropoda, Heteropoda* and Cephalopoda are exclusively marine, and the same number, namely, besides the forms already referred to, the Infusoria and Rhizopoda, the Hydroid polypes, Rotatoria, Bryozoa, Turbellaria, and Annelida, are common to both media, amongst which, however, the very numerous sections are purely marine (Sertularina, Bryozoa Stelmatopoda†, and the numerous, very highly developed order of the Annelida), whilst the sections proper to the fresh water are less rich in species, like the freshwater Polypes and Bryozoa (*Hydrina* and Bryozoa Lophopoda) and the *Planariæ* in the most restricted sense.

The Batrachia furnish the only example of a class of animals which is entirely wanting in the sea, and yet they are water-breathers, at all events temporarily : we are acquainted with marine Tortoises, marine Lizards (Darwin's *Amblyrhynchus cristatus* upon the Galapagos Islands), and marine Snakes (*Hydrophis*), besides the notorious Norwegio-American one, but, in spite of Seba and Schiller's 'Taucher', not a single Sea Toad or Sea Newt. Of the strictly air-breathing classes, lastly, certain representatives live constantly in the sea ; of the Birds and Insects only a few venture temporarily into and under the water, both fresh and salt, but live essentially above its surface‡ ; amongst Insects, we have here especially the small, apterous, Carabideous Beetle

[* The author has previously regarded the Heteropoda as forming a portion of the class Gasteropoda.—TRANSL.]

† According to Dumortier and Van Beneden, however, the freshwater genus *Paludicella* belongs to this group.—[According to Professor Allman ('Monograph of the Freshwater Polyzoa,' Ray Society, 1856), both *Paludicella* and *Urnatella*, although freshwater genera, belong to the group above mentioned ; whilst on the other hand, the marine genus *Pedicellina* appears to have a bilateral lophophore, which would cause its location amongst the freshwater forms. *Fredericella* also, a freshwater genus, possesses a funnel-shaped lophophore. Professor Allman's classification, in which the two orders of Polyzoa are distinguished by the presence or absence of an epistome, or lobe in the vicinity of the mouth, does not get rid of this appearance of marine forms in fresh water and *vice versa*.—TRANSL.]

‡ The author here seems to have forgotten the existence of whole families of Beetles and Bugs, which live habitually beneath the surface of the fresh water, whilst the larvæ of many of the former are even adapted to aquatic respiration. The larvæ of a great proportion of the Neuroptera also are strictly aquatic, and those of many Diptera live in water, although most of them breathe air.—TRANSL.]

(*Blemus fulvescens**), observed by Audouin, which remains concealed under stones during the flood-tide, and lives in places which are not left bare by every ebb; the other so-called marine Insects generally live only in brackish water, or roam about upon its surface, like *Halobates*, which is analogous to our *Hydrometra*†. As regards the Arachnida, the answer to the inquiry concerning marine forms, depends upon whether the *Pycnogonidæ* be included with them; the most recent and important authorities answer this in the affirmative. Amongst the Myriapoda, the occurrence of *Glomeris ovalis* in the sea is very problematical; at any rate, it does not live in *Oceano Europæo*, as Linnæus stated, nor are we acquainted with any fresh-water Myriapoda.

For the classes, therefore, the number of the exclusive and common ones would be nearly equivalent. Of the seven primary types of the animal kingdom, on the contrary, only one, that of the Echinodermata, is exclusively marine; the others are common to the sea and fresh water, and the majority (4) also to the land: none of them are wanting in the sea. We may therefore establish the general proposition, that from the agreement in family of an animal of unknown origin, with another, of which the origin is known, we may in most cases (in the Crustacea in three-fourths, in the Mollusca in nearly nine-tenths) arrive at a probable (inductive) conclusion with regard to the derivation of the unknown form; and that the same applies for a fraction of the orders and classes, which often rises to the half of the primary type to which they belong, and for the Echinodermata‡ even to unity.

On the other hand, descending in the systematic scale, only an inconsiderable number of genera (in the modern sense = groups of species) are common to both media, even in the Fishes probably not more than 1 per cent.; and with regard to species the number falls to 0 in the Mollusca and Crustacea, except some cases which are still doubtful (*Paludinella thermalis* or *acuta*, *Gammarus locusta*); amongst Fishes, not only is the occurrence of *Gasterosteus trachurus* in the North Sea asserted by all the ichthyologists of that region, from Gronovius to Nilsson,

[* This Insect forms the type of Leach's genus *Aëpus*, of which a second species, the *Aëpus Robinii*, has lately been discovered on the coasts both of France and England. Besides these, a considerable number of Beetles, principally belonging to the extensive group of the Brachelytra, so many of which are singular in their habits, are found upon our shores in very similar positions.—TRANSL.]

[† Or rather, *Gerris*.—TRANSL.]

[‡ This can only hold, with regard to the Echinodermata, if we regard them, with the author, as representing a distinct primary type of animal structure; this, however, is by no means generally admitted.—TRANSL.]

but we also find, as a peculiar phænomenon, the migration of marine Fishes up the streams, in order to spawn, and, more rarely, that of river Fishes into the sea for the same purpose (the Eel; see Spallanzani's observations in Commachio, G. von Martens' *Italien*, ii. p. 334). Here therefore they are even the same individuals which alternately inhabit the two media; and perhaps this is not all, for it is said of several lakes that fishes which have immigrated into them from the sea are unable to find their way back, in consequence of the deficiency of current, and that they remain, as well as their posterity, in the fresh water; and on the other hand, Nilsson in his *Scandinavian Fauna*, in referring to our Shad (*Alosa*), does not say a word about its ascending into the fresh water, but, on the contrary, states that, according to the observations of Malm, it spawns between the rocky shelves of Gothenburg (Götheborg's skärgård).

Marine Mammalia also sometimes ascend the rivers, but with less regularity, and principally following the migratory Fishes, as was observed by Simpson* to be the case with Seals in the Oregon river as far as the rapids of Les Petites Dalles. Whether the common Seal which, according to E. Boll†, was killed in the Elbe near Dessau, is to be referred to this category, or whether it was one that had escaped from human custody, remains doubtful as a single case at such a distance from the sea.

The great richness of the sea is explained not only by its greater extent, but also by its more uniform temperature. The fresh waters stand in the same relation to it, as a continental to an insular climate; their alternation of temperature is the principal hindrance to their becoming populous, and this attains its maximum by freezing in the colder zones; with the increase of temperature the populousness of the fresh waters increases, but is still limited in the subtropical zone by partial desiccation. In the tropical zone, the conditions of temperature of the fresh waters approach most nearly to those of the sea, and with them their populousness.

BIBLIOGRAPHICAL NOTICES.

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AFTER an interval of nearly two years, we have to call the attention of our readers to the appearance of a second volume of this highly

* Narrative of a Journey round the World, 1841-42.

† Archiv des Vereins für Naturkunde in Mecklenburg, 10 Heft, 1856, p. 73.



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