REPORT ON THE BRACHIOPODA OF ALASKA AND THE ADJACENT SHORES OF NORTHWEST AMERICA.

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Having during the last ten years had an opportunity of examining nearly all the known material, much of which is derived from the collections of myself and party during the period mentioned, I am able to present what appears to be a tolerably complete synopsis of the species inhabiting the northwest coast from Santa Barbara Channel, California, to the Arctic Ocean. To this I have added the results of some study of the general subject, regarding the relations of certain groups of species and a hypothetical explanation of certain very singular facts.

TEREBRATULIDÆ.

1. Terebratulina unguicula.

Terebratula unguicula, Cpr. P. Z. S. Feb. 14, 1865, p. 201, fig. 1-4. Cooper, Geogr. Cat. Cala. Moll. p. 3, 1866.

Terebratulina unguicula, Dall. Cat. Recent Brach., Proc. Phila. Acad. Nat. Sci., p. 177, 1872.

T. juniore "*Terebratulinæ capiti-serpentis*" simillima, sed latiore; costis conspicuis, interdum obtusioribus, aliis intercalantibus; testa adulta valva inferiore subelongata, inflata, marginem versus haud planata; umbone valde tumente, latiore, aperta; striis radiantibus conspicuis; marginibus granulatis, undulatis; intus amento majore, latiore, annulato, bisinuato, in testa juniore dorsaliter interrupto. Lon. 15 mm.; Lat. 12 mm.; Diam. 9 mm.

San Diego, Cal., to the Aleutian Islands. San Pedro, Cal., Cp.; Monterey, Cp.; Neeah Bay, W. T., Swan; Victoria, V. Id. Lord, J. Richardson; Port Etches; Shumagin Islands; Unalashka; Dall. Range, low water to 100 fathoms, those from deep water the largest, adhering to shells and stones. Thirty-eight specimens examined.

This species is readily separated from *T. caput-serpentis*, *T. Japonica* and other species, which strongly resemble it externally, by the broad loop which is usually open instead of being closed as the genus requires. However, it finally becomes closed in fully adult specimens which reach the size of *T. caput-serpentis*. In

describing it from immature examples, Dr. Carpenter was led by this peculiarity to describe it as a *Terebratula*, and it was a number of years before I was able to find a fully developed specimen. All that I have seen from southern localities have been immature.

2. Terebratella frontalis.

Terebratula frontalis, Midd. Malak. Ros. III, p. 2. Sib. Reise. II, p. 241, pl. 18. fig. 9–14, 1847.

Terebratella frontalis, Dall. Cat. Rec. Brach, l. c. p. 184.

T. suborbiculari, solidula, calcarea, incrementi periodis irregularibus aspera, sordide lutescente; valvis convexitate æqualibus; linea marginali rectiuscula integerrima; valva dorsali postice producta, vix recurva, late truncata, foramine magno, latius aperto, interrupto; area cardinali augusta, utrinque interiora versus dente cardinali terminata; valva hæmali suborbiculari aut transversim ovali, sulco mediano nullo; apophysis "*Terebratellæ*" formis: Lon. 18 mm., Lat. 18 mm., Diam. ventr. 9 mm.

Western Aleutians from Atka Island westward; the Okhotsk and Japan Seas. Atka, Amchitka, Attu, Dall; Okhotsk Sea, Middendorf; Japan Seas, Capt. St. John. Range from low-water mark to forty fathoms. Sixty-five specimens examined.

The rude appearance, ashen color, and remarkably wide foramen distinguish this species from any other of the genus.

3. Terebratella occidentalis.

T. occidentalis, Dall, Proc. Cal. Acad. Sci., 1871, IV, p. 182, 1871, pl. I, fig. 7.

Waldheimia Grayi, of Cala. authors, not of Davidson.

T. transversa, rosacea aut miniata, costis radiantibus angulatis ornata; valvis flexuosis, convexiusculis lateraliter angulatis; margine cardinali lente curvato; apice vix eminente; foramine magno, interrupto, latius aperto; cardo et apophysis ut in "*Terebratella;*" area cardinali angusta, lata, conspicua. Lat. 18 mm., Lon. 12 mm., Diam. ventr. 5 mm.

San Francisco to Monterey, Cal. Pigeon Cove, Stearns; Monterey, Dall, Canfield, Cooper. Near low-water mark, to —? fathoms. Five specimens examined.

This rare species externally resembles, in its sharp ribs, transverse form, and deep crimson coloring, the above-named species from Japan, but it is a *Terebratella*, and authentic specimens of *T. Grayi* show that species to be, as it was described, a *Waldheimia*. The color and deeply notched margins distinguish it from

the common northern *T. transversa*, the only species with which it is likely to be confounded. It is probable that careful search would reveal the habitat of this species, when it might be found more abundantly. Most of the specimens known have been picked up on the beach.

4. Terebratella transversa.

Terebratula transversa, Sby. Thes. Conch. 1, p. 261, pl. 72, fig. 114–115, 1846. Not of Gould, Proc. B. S. N. H. vii, p. 323, 1860.

Terebratella caurina, Gould, Proc. B. S. N. H. iii, p. —, 1850. Exped. Shells, p. 468, pl. 44, fig. 582.

Terebratella caurina, Gld. Otia Conch. p. 97, 1862. Cpr. Sup. Rep. B. As. p. 636, 1864.

Terebratella transversa, Dall. Cat. Rec. Brach. l. c. p. 185.

T. variabilis, fusco-cinerea, transversa, convexiuscula; costis angulatis numerosis interdum bifurcatis plerumque radiata; margine ventrali flexuoso; apice acuto, angulari; rostro brevi, curvato, foramine magno, interrupto; area cardinali elevata, lata, planata, margine carinato; apophysis curta, "*Terebratellæ*" aliis simillima. Lat. 25–40 mm., Lon. 16–25 mm., Diam. ventr. 5–15 mm.

Shumagin Islands to Oregon. Coal Harbor, Shumagins; Semidi Islands; Kadiak; Port Etches; Sitka Harbor; Dall. Victoria, V. Id., J. Richardson, Hepburn; Neeah Bay, Swan; Puget Sound, Kennerly; Oregon, U. S. Expl. Exped. Range from low-water mark to twenty fathoms. Sixty specimens examined, including Gould's type.

This abundant species is very variable in form and size; the northern specimens are the largest. Some are as transverse as a *Spirifer*. Gould's *T. transversa* from Japan was never figured, and cannot now be identified. It was not this species, which has in any case the priority. Sowerby's figure is sufficiently characteristic to render its identification with Gould's *caurina* tolerably certain.

The transverse form in most cases, the ashen-gray color and coarse ribs render its identification easy.

5. Laqueus californicus.

Terebratula californica, Koch, Kuster's Martini, viii, pl. 26, figs. 21–23.

Waldheimia californica, Gray, B. M. Cat. p. 60, No. 8, Cpr. Sup. Rep. Br. As. p. 568, 636.

Laqueus californicus, Dall, Am. Journ. Conch. vi, p. 123, 1870; pl. 7, fig. f., pl. 8, fig. 9–10. Cat. l. c. p. 186.

T. magna, rhomboideo-ovalis, valde inflata, tenuis, rufescente,

striulis incrementi solum insculpta; valva hæmali ventricosa, sulco mediano nullo, margine postico vix angulato; valva dorsali posticè rostrata, foramine minimo, integro; rostro brevi valdè incurvato; apophysis ut in "*Laqueus.*" Lat. 45 mm., Lon. 55 mm., Diam. 35 mm.

Port Etches, Prince William Sound, to Catalina Island, Cal. Port Etches, Dall; Victoria, J. Richardson; Catalina Id., Cooper. Range from fifteen to one hundred and twenty fathoms, the larger specimens generally from deep water. Twelve specimens examined.

This species may be recognized by its large size, smooth rufous exterior, and small and complete foramen. It somewhat resembles *Waldheimia venosa*, from Cape Horn, but has not the strongly marked venations, and is of a different form and color. It is everywhere rare, owing to its deep-water habitat.

6. **Megerlia Jeffreysi.**

Ismenia? Jeffreysi, Dall, Am. Journ. Conch. vii, p. 65, pl. xi, fig. 7–10, Mar. 1871.

Megerlia (*Ismenia*) *Jeffreysi*, Dall, Cat. l. c. p. 187.

Waldheimia cranium, jun., Friele (ex parte) Vidensk. Forh. p. 2, pl. i, f. 9 a–i, 1875.

Testa parva, lenticularis, tenuis, orbiculato-trigona, cinereo-alba; valva minor convexiuscula, suborbiculata, margine recto, apice inconspicuo, vix angulato; valva major convexior, apice truncato, brevi, recto, foramine modico, interrupto; area cardinali inconspicua; apophysis tenuissima, plerumque exilis, "*Megerliæ sanguiniis*," simillima. Lon. 10 mm., Lat. 10 mm., Diam. ventr. 4 mm.

Deep water, N. E. Atlantic; Semidi Islands to Victoria in the Pacific. N. E. Atlantic, 155–345 fathoms, Jeffreys, with *Waldheimia cranium.* Semidi Islands; Port Etches; Dall.; Victoria, V. Id., J. Richardson. Sixteen specimens examined. For so rare a shell this has an extraordinary range. It much resembles the young of the last species, but never attains much greater size than half an inch in diameter, and has an incomplete foramen. The color varies from ashy yellow to rufous. The specimens from the northwest coast were obtained in from fifteen to twenty fathoms water.

It is probable that it has frequently been taken for the young

of other species, and that a careful examination of small specimens would much extend our knowledge of its distribution.

The septum is generally almost evanescent.

7. **Magasella aleutica.**

Magasella aleutica, Dall., Proc. Cal. Acad. Sci., Dec. 1872, p. 302, pl. I., fig. 6. Cat. l. c. p. 188.

T. parva, subinflata, solida, orbiculato-trigona, rosacea aut concentricè rubido-picta; valva minor convexa, suborbiculata, margine leviter sinuato, apice inconspicuo; valva major convexior, apice erecto, truncato, conspicuo, foramine amplo interrupto; area cardinali distincta, apophysis tenuissima, septum conspicuum munita. Lon. 10 mm., Lat. 9 mm., Diam. ventr. 4 mm.

Aleutian Islands to Port Etches.

Kyska Id.; Adakh Id.; Atka Id.; Unalashka Id.; Shumagin Ids.; Port Etches; Dall. Range from low water to ten fathoms. Fifty specimens examined.

This little species differs externally from the young of *T. frontalis*, only by its rosy color and neater proportions; from young *L. californicus* by its open incomplete foramen, and from the last species by its greater solidity, bright tints, loop, and prominent septum. It has somewhat the aspect of *M. inconspicua*, Sby., from New Zealand.

8. **Magasella radiata, n. s.**

M. testa minuta, cuneata, triangulata, radiato-costata; haud inflata; costis radiatis circa xvi. ornata; lineis concentricis sparsim striata; foramine aperto, interrupto; deltidium nullum; apice subacuto; testa lutea aut cinereo-alba. Lon. 0.5 mm., Lat. 5 mm., Lon. neural valve, 4 mm.

Shell small, nearly triangular, the greatest width near the anterior margin, which is gently rounded; somewhat flattened or compressed, with about sixteen moderately strong radiating ribs or costæ on each valve. These are continuous from the beak to the margin, not divaricating; some lines of growth well marked; foramen incomplete, large; apex rather acute; color waxy or ashy-gray. Interior as usual in this genus, with a strong septum. Shell quite solid and strong. Length 0.2 in.; of neural valve 0.17 in.; width 0.2 in.

Popoff Strait, Shumagin Islands; one specimen, with *M. Aleutica* adhering to stones at lowest spring tides.

This species is quite distinct from any other in the region. It

is sculptured somewhat like *T. transversa*, from which it is sufficiently distinguished by its form, absence of median flexure, size, compression, and apophyses. It also recalls in some respects *M. Patagonica*, which has divaricating costæ, and is of a different shape.

RHYNCHONELLIDÆ.

9. **Rhynchonella (Hemithyris) psittacea.**

Anomia psittacea, Gmelin, Sys. Nat. 3348.
Hemithyris psittacea, D'Orb. Pal. Fran. Ter. Crèt. IV. p. 342, 1847.
Rhynchonella psittacea, Auct., Rve. Conch. Ic. pl. 1, fig. 2, a–c.
Hemithyris psittacea, Dall. Cat. l. c. p. 196.
Rhynchonella Woodwardi, A. Ad. Dav. P. L. S. 1871, p. 309.

T. subglobosa, postice acuminata, tenui, cornea, nigricante; valvis inæqualibus, radiatim concinne sulcatulis; linea marginali ex umbone declivi, demum ascendente et antice valde sinuata; valva dorsali postice acuta, recurva, antice deflexa, sulco mediano, lato, area cardinali inconspicua, deltidiis augustis, ad latera foraminis coalescentibus; valva hæmali, ventricosiore, dentibus cardinalibus internis ex umbone porrectis, recurvis duobus; margine valvarum integerrimo. Lon. 25 mm., Lat. 22 mm., Diam. ventr. 16.5 mm.

Boreal and Arctic Seas. On the northwest coast from Fuca Strait to the Arctic; Japan; North European Seas; everywhere abundant.

This well-known species is of circumpolar distribution, varying in depth from low-water mark to two hundred fathoms or more. In examining specimens from the shores of Alaska, I thought at first that by their coarser growth and grooving they were distinguished from Norwegian specimens. But after an examination of several hundreds of specimens, I have been forced to conclude that the differences noted were only individual or local peculiarities. I have observed in a few instances the brachial "arms" protruded from the shell in living examples.

LINGULIDÆ.

10. **Glottidia albida.**

Lingula albida, Hinds, Voy. Sulph. p. 71, pl. 19, fig. 4, 1844.
Glottidia albida, Dall. Am. Journ. Conch. vi. p. 157, pl. 8, fig. 1–6, 1870. Cat. l. c. p. 204.

T. oblonga, levi, complanata, anticè truncata, albida seu brunneo-maculata; valva major, intus laminis duobus ex umbonem

divaricatis; valva minor, lamino uno, mediano, prope apicem munito; pediculo plerumque brevi. Lon. test. 25 mm., Lat. 10 mm., Lon. tot. 50 mm.

Monterey, Cal., southward.

Monterey, Dall.; Santa Barbara, Stearns, Newcomb; Catalina Island, Cooper; San Diego, Hemphill; ten to sixty fathoms, muddy bottom, rarely on tidal flats in mud at lowest water.

This species has not been found to the northward of Monterey, though it may yet turn up somewhere. It is usually not over three inches in length, peduncle included. Like other species of *Lingulidæ*, when young it is free, and burrows in the mud. Adult specimens, with favorable opportunity, often fasten themselves to a pebble or fragment of shell by the distal extremity of the peduncle. This has been also observed with *Glottidia pyramidata*, Stm., in Florida, by Mr. F. B. Meek, though that species had been supposed to be always free. It would seem probable, from information communicated to me by Mr. Meek, that these creatures are of rapid growth, and live at most but one or two seasons. It is the only species of the *Lyopomata* yet found on the northwest coast.

The following species, or supposed species, have been erroneously referred to the northwest coast, sometimes from mistaken identity and sometimes from other causes.

a. *Terebratulina caput-serpentis*, L., in error for *T. unguicula*, Cpr. Real habitat, North Atlantic.

b. *Waldheimia Grayi*, Davidson, by erroneous identification with *Terebratella occidentalis*, Dall. Real habitat, Japan.

c. *Terebratella Coreanica*, Ad. & Rve., by erroneous identification with *T. transversa*, Sby. Real habitat, Japan Seas.

d. *Terebratella pulvinata*, Gld. Erroneous habitat caused by confusion of U. S. Exploring Expedition labels. Real habitat, Tierra del Fuego and vicinity.

e. *Discina striata*, Schum., as *Orbicula Evansi*, Davidson, "Bodegas." Real habitat, Cape Palmas, W. Africa, and vicinity.

In this connection it may be allowable to call the attention of naturalists to certain facts connected with the group of arthropomatous brachiopods which have been with me for some years a subject of reflection. Not having been able to suggest any

satisfactory explanation of the relations which appear to exist between certain groups of the *Terebratulidæ*, I desire to draw the attention of others to them, in the hope that some solution may be arrived at, and to place the facts on record. In 1871 I proposed the name of *Magasella* for a group of *Terebratulidæ*, mostly composed of small species, and characterized, among other things, by an incomplete foramen and a high septum, standing up from the middle of the brachial valve, and to which the loop is attached or appressed for a considerable portion of its length.

This section of the family has been recognized as valid by several competent naturalists. There are known, in all, about eleven well characterized species of this group, beside one doubtful species, *M. crenulata* Sby. Four of these species have been described by myself, and most of the others, not recently described, have but lately been discriminated from species of *Terebratella*, etc. In working over the group certain facts become prominent, which cannot be without significance when carefully considered. These facts may be formulated as follows:—

I. Each species of *Magasella* (with the exception of its generic characters of apophyses and foramen) has a more or less pronounced likeness to some species of another section of the *Terebratulidæ*. This likeness, in some cases, approaches identity when the generic characters and size are taken out of the question.

II. The species resembled are invariably members of a section of the family possessing a long or complicated loop, and usually a median septum. In fact most of them are Terebratellas.

III. The species resembled, usually though not invariably, inhabit the same faunal region as the particular species of *Magasella* which may be under consideration, and are often found living with the latter in the same localities.

IV. When there is an abundant species of *Terebratella*, for instance, on any coast, it is almost invariably accompanied by a species of *Magasella* of similar specific characters.

This law is so invariable in well explored regions, that I should feel hardly any hesitation in predicting the existence of a companion *Magasella*, in a region not thoroughly explored, when the prevalence in that region of a species of the section *Magasinæ* became known.

V. The genera *Terebratella* and *Waldheimia* being the most abundantly represented of any of the genera of recent brachio-

poda, may be said to represent to some extent the most fully developed of the brachiopods; an inference borne out by the complication of the loop as compared with that of other groups. The loop of *Magasella*, being the most complicated of any (except the few species of *Megerlia*), may thus be the latest exhibition of evolution in this direction. The genus *Magas* (with which *Mannia* of Dewalque may perhaps be synonymous) is not very closely related to *Magasella*, and leaving it out of the question it may be added that, so far as known, *Magasella* occurs only in a recent state; another argument for its comparatively modern evolution.

In illustration of the above, the following parallel lists may be adduced showing the several species of *Magasella* with their companion species of other groups and the region to which they belong. Such as exhibit specially remarkable similarity in specific characters are marked with an asterisk; those exhibiting only a general resemblance are not so marked.

Magasella Adamsi, Dav.	?	Japan.
M. aleutica, Dall.	*Laqueus californicus*, Koch.	Alaska.
M. Cumingi, Dav.	?	New Zealand.
M. Evansi, Dav.	*Terebratella cruenta*, Dillw.	New Zealand.
M. flexuosa, King.*	*Terebratella dorsata*, Gmel.	Patagonia.
M. Gouldii, Dall.	*Waldheimia Grayi*, Dav.	Japan.
M. inconspicua, Sby.*	*Terebratella rubicunda*, Sol.	New Zealand.
M. lævis, Dall.*	*Terebratella pulvinata*, Gld.[1]	Patagonia.
M. patagonica, Gld.*	*Terebratella dorsata*, Gmel.	Patagonia.
M. radiata, Dall.	*Terebratella transversa*, Sby.	Alaska.
M. suffusa, Rve.	?	Unknown.

With some hesitation I add also—

Megerlia Jeffreysi, Dall.*	*Wald. cranium*, Müll.	N. E. Atlantic.
Megerlia sanguinea, Ch.*	*Wald. picta*, Ch.	Indo-Pacific.

Of the three species queried, *M. Adamsi* resembles *Waldheimia Grayi*, jun., in a general way except in coloration; *M. Cumingi* is very peculiar, unlike any other recent species; and the habitat and probable companion of *M. suffusa* are alike unknown.

I have not included the section *Ismenia* (*Megerlia*) in my preliminary remarks, but the species, cited above, present, in a less

[1] A third, related to *pulvinata* as that is to *lævis*, is *Waldheimia venosa*, Sol.

marked manner, similar peculiarities. The companion of *Ismenia Jeffreysi*, on the Alaskan coast, would be *Laqueus californicus*, to which the Alaskan specimens show some similarity; while those from the N. E. Atlantic offer similarities which are very marked with the young *W. cranium*. Nevertheless, except a slight difference in color and solidity, there are no reasons other than geographical for separating the Atlantic and Pacific shells which I have called *I. Jeffreysi*.

With regard to *W. picta*, I can only judge from figures and the remarks of descriptive authors, who all point out its similarity to *T. sanguinea*. Both are Indo-Pacific in distribution, and have been reported from Japan. In this connection it may be noticed that the *Magasella* and its companion do not always occupy the same region at *all* points, but do usually meet at some common point in their distribution.

In the first portion of the list, the most striking instance of similarity is that which is shown by *Magasella inconspicua* and *Terebratella rubicunda*, jun. These appear absolutely without differential specific characters, though the generic characters of the individuals compared may be clearly marked.

It must be clearly understood and borne in mind, that the similarity between the *Magasella* and its companion is usually only remarkable when the *young* of the latter is compared with the *adult Magasella*. The adult companion shells frequently acquire characters belonging to maturity which, though too intangible to be of specific value, much obscure the original resemblance. At first the idea suggested itself, as a matter of course, that *Magasella* (and *Megerlia*) was an immature form, especially as it wants the median brachial coil as do the immature *Terebratellæ*.[1] The evidence against this hypothesis seems to me to have greater weight than that in favor of it, which latter chiefly arises, as far as *Magasella* is concerned, from the similarity of specific characters, and greater or less agreement in geographical range. Since the preceding portion of this article was written, I have been made

[1] This paper had been prepared and read before the Buffalo meeting of the Amer. Assoc. up to the above point, when the paper by Mr. Herman Friele, published in the Vidensk. Selskab. Forh. for 1875, was received from the author, and afterwards supplemented by a series of his specimens. The subsequent portion has since been recast to more fully present the whole subject.

aware that a species of *Megerlia* (subg. *Ismenia*) has been claimed as the young of *Waldheimia cranium* by Herman Friele. I will defer the examination of this special instance until the general case can be presented.

If *Magasella* be the young of the various forms herein denominated "companions," 1st, the distribution of any two species so related to each other should absolutely coincide; 2d, the young should all be *Magasellæ;* the adults (barring dwarfs), all of the "companion" genus; 3d, actual study of the embryology and young stages should be able to trace the edentulous stage into the *Magasella* stage, and that into the final "companion" stage.

Finally we should expect, with some show of reason, that the relations of the one to the other in development should be in harmony with the development of the group as a whole in geological time and organic differentiation. These expectations, though reasonable, from analogy in a multiplicity of other organisms, are not absolutely to be insisted on, while the three preceding propositions are absolute requirements.

What agreement exists between the facts and these requisites?

1st, as regards distribution: There is abundant evidence that the *Magasella* and its companion are not inseparable. For instance, *M. aleutica* and *Laqueus californicus* meet only about Port Etches, which is the southernmost limit of the first and the northernmost limit of the second. *M. aleutica* in that part of its district, where it is most abundant, has no associate brachiopod of its family except a *Terebratulina*. The same is probably true of *M. radiata*, which is found at the extreme northern limit of *T. transversa*, and is absent where the latter flourishes in abundance. In the second group, *W. picta* is reported from but one locality in Japan, while *Megerlia sanguinea* is rather common there; with regard to their joint occurrence at the Sandwich Islands I am a little suspicious that the *Megerlia* may have been taken for the *Waldheimia* by those unfamiliar with the apophyses, as I have seen large numbers of the former from that locality, but not a single *Waldheimia*.

Again *Megerlia Jeffreysi* appears to be common in the North Sea and North Atlantic, and is not rare in the southeastern portion of Alaska and British Columbia, reaching from the Semidi Islands to Puget Sound, while its Atlantic companion *Wald. cra-*

nium and the genus to which it belongs[1] are unknown in the Pacific district above described, and its Pacific associate has not been found north or west of Port Etches. It is impossible to say whether similar discrepancies occur in the distribution of the other species, as the regions they inhabit have not yet been investigated with any thoroughness.

2d. As regards the young and adult forms: Of several of the species of *Magasella*, the adults, or at any rate the largest specimens which have come to hand, are nearly or quite as large as the "companion" when also adult. This is especially true of the typical species of *Magasella*, *M. Evansi*, of which I have a specimen fully as large as the usual size of *T. cruenta*, and much larger than some of the younger specimens of *cruenta*, which have the typical loop of *Terebratella* proper. The same is true of *M. flexuosa* as related to *Terebratella dorsata;* and Pacific adult specimens of *Megerlia Jeffreysi* are as large as the usual size of *W. cranium* in the Atlantic. Nevertheless it is true that the *Magasellæ* are usually smaller than their "companions."

I have recently had the opportunity of examining a large series of young *Terebratella rubicunda* from New Zealand, and also a lot of *Magasella inconspicua* from the same locality. No two "companions" are more nearly identical in specific characters. In fact no one can separate them without examining the apophyses. Yet in the youngest stages of both (as well as the adults) the generic characters are clearly and unmistakably defined. Mr. Davidson has kindly informed me that he has had a similar experience with *T. cruenta*, and has come to an opinion that it is highly improbable that the *Magasella* is an immature form; in fact there seems to be no good reason for adopting that view of the matter.

Again, in this connection, attention must be called to the fact that sometimes two *Magasellæ* will have only one "companion" species between them, as *M. flexuosa* + *M. Patagonica* versus *Terebratella dorsata*, and one *Megerlia* has two *companions*, one in the Pacific and the other in the Atlantic.

There are also some whose "companions" are unknown, or which may be without companions, as *Megerlia truncata* in the Mediterranean (a sure case) and *Magasella cumingi* in New Zealand. Both of these are such remarkable forms that it is almost

[1] *W. cranium* has been erroneously accredited to Japan.

unreasonable to treat them as if possibly immature. In fact, in regard to all the better known species of *Magasella*, those who have studied them most will be the last to admit that they are anything but mature organisms, and, by analogy, it is natural to suppose that other species less known, but presenting equal marks of maturity, are adult also.

3d. In relation to the progressive development. Of course this is practically the test of the whole question, but it may be fairly claimed that it is a test which must be applied to each individual species before the question can be considered settled. Data are few and far between on this branch of the subject. Embryological material to a considerable amount is available, but mostly relating to the species with short apophyses, or belonging to other families. Morse has shown that the loop of *Terebratulina* begins as two spikes at the cardinal margin, and the two spikes increase in length, and finally coalesce in the median line. I have observed the same thing in *Terebratula cubensis*. It is self-evident that the loop of *Waldheimia*, when adult, is merely an extension and reflection of the ideal loop of *Terebratula*, and the inference therefrom would be that its development progresses in the same way. This opinion I am, at present, inclined to adopt. In the section *Magasinæ*, where all the species have the loop supplied with an additional support in the form of a septum, a different state of things is to be found. The septum is the first part of the skeleton to make its appearance.

In *Terebratella transversa* (*caurina*, Gld.) the youngest specimens, a twentieth of an inch in diameter, showed a septum bifurcate at top and notched on the anterior edge. The anterior part of the loop is completed or nearly so, before the lower longitudinal processes are complete from the hinge to the septum. In *Magasella aleutica* the fry has a strong septum, entire and not bifurcate, before any of the remainder of the loop is developed. In *Megerlia Jeffreysi* the youngest specimens I have seen ($\frac{1}{10}$ of an inch in diameter) have the loop well developed, and (whether this is an abnormal feature or not, I am not prepared to say) laterally compressed so that the longitudinal parts of the loop are proportionally closer together (in most cases) than in larger specimens, and the septum is proportionally stronger and larger. In a large proportion of the well-grown specimens of this species, there seems to be a tendency for the septum and other delicate portions of the

loop to become abortive, but this I shall further discuss later. In all the *Magasellæ* the septum is the strongest and most permanent part of the skeleton.

In *Terebratella spitzbergensis* we have a species which seems to have just stopped short of being a *Magasella*, and *Wald. Davidsoniana*, Seq., seems to have a tendency in the same direction, while the strong septum of *Wald. septigera* only needs a pair of transverse processes to make it a *Terebratella*.

I have not seen very young specimens of *Laqueus californicus;* the youngest *Terebratella frontalis* which I have seen agree in the development of septum and loop with *T. transversa*, Sby.

It seems, therefore, that the early development of some of the "companion" species is incompatible with the idea of their young stages agreeing with *Magasella*. If we assume that what is true for two species of *Terebratella* is also true for the rest, six species of the seven *Magasellæ* known to have "companions," will have been taken out of the doubtful category. I feel sufficiently certain that *M. aleutica*, on geographical grounds, cannot possibly be the young of *Laqueus californicus*.

There are then remaining one species of *Magasella* and two of *Megerlia*, which have *Waldheimia* "companions." Of the younger stages of *Waldheimia* we have yet no positive information.

Mr. Friele in his paper previously referred to, and which I know by the plates only, as it is in the Norwegian language, which I have not attempted to translate, appears to have primarily assumed that the *Megerliæ* were the young of *Waldheimia cranium*, because of their external resemblance and co-ordinate distribution as far as known to him. But on the examination of a good series of young *Megerlia* he found a state of things which seemed to confirm his first assumption.

Mr. Friele found the smaller specimens conforming to the general type of *Megerlia*. Those with a pronounced septum he referred to *W. septigera*, but my own impression is that these merely exhibited not unusual individual peculiarities. To me, in examining the specimens, the transition from the one to the other, as regards the septum, seemed very gradual. He found larger specimens, in which the upper processes connecting the reflexed portion of the loop with the longitudinal bands of the loop, were abortive. In this case the loop remaining was generically that of *Terebratella*. In others, again, the septum had ceased to be con-

nected with the transverse processes, and the latter in some cases had become disconnected from one another. In this stage only the remnants of the transverse processes remained to distinguish the loop from that of a *Waldheimia*. Hence he very naturally concluded that he had before him the stages of development of a *Waldheimia*, which must necessarily be either *cranium* or *septigera*, no other species being known from that region. The result was his paper. I am far from denying that this may possibly be the case. At any rate, Mr. Friele is entitled to great credit for calling attention to these very interesting facts.

Thanks to his kindness, I have been enabled to examine a series of nineteen specimens of *Megerlia* of different ages, which, with a number in my own collection from the northwest coast, enabled me to make a pretty thorough study of them, and incidentally to confirm the general accuracy of his rather formal, but still characteristic figures.

It seems to me, however, that another hypothesis will explain them, if not equally well, yet in greater harmony with the analogies of the case, and, taking the geographical distribution of *Megerlia Jeffreysi* into account, with greater probability of accuracy.

In the first place it is to be noted that the specimens offered to me an absolute gap between the long characteristic loop of *W. cranium* and the broad, elevated, rather short loop of the *Megerlia*. Even in the absence of the missing parts the loop was totally unlike that of *W. cranium*,[1] and if adult would as a *Waldheimia* be specifically distinct from *W. cranium*. Secondly, all the specimens showed a remarkable weakness and tenuity of the loop even where complete; it seemed as if the abortion of part of the loop was caused by an absence of lime; or as if the specimens, growing rapidly, and necessarily being obliged to dissolve the loop and redeposit it on a larger scale (a process constantly going on), had been unable to make the latter part of the process keep pace with the former. There was nothing to indicate that the loop was not rather an unfinished *Megerlia* than one in a process of metamorphosis. Some Alaska specimens in the National Museum are much larger and stouter in every respect, than the largest of the supposed metamorphic specimens, and also quite equal to the

[1] Except a few specimens, which differed from the rest, and were undoubted young (but not smallest) specimens of *W. cranium*.

smallest typical *W. cranium*, but they show no degradation of the *Megerlia* type of loop.

I have examined this subject in a good deal of detail, because I believe that in it lies the key to some important generalizations. Certainly if one may have transformations including three now accepted sections or genera in the life of one individual, it will necessitate some changes in our systematic arrangements. I do not think we have in this case, yet it is none the less possible, and would not be the first instance among invertebrates.