

On the classification of *Corallimorphus* (Anthozoa: Corallimorpharia): the ratio of discal and marginal tentacles

J.C. den Hartog & S.D. Grebelnyi

Hartog, J.C. den & S.D. Grebelnyi. On the classification of *Corallimorphus* (Anthozoa: Corallimorpharia): the ratio of discal and marginal tentacles.

Zool. Verh. Leiden 345, 31.x.2003: 163-171, figs 1-12, table 1.— ISSN 0024-1652/ISBN 90-73239-89-3.

J.C. den Hartog, Nationaal Natuurhistorisch Museum, P.O. Box 9517, 2300 RA, Leiden, The Netherlands.
Recently deceased.

S.D. Grebelnyi, Marine Research Laboratory, Zoological Institute Russian Academy of Sciences, Universitetskaja nab. 1, St-Petersburg 199034, Russia (e-mail: marine@zin.ru).

Key words: Corallimorpharia; *Corallimorphus*; nematocysts; ontogeny; distribution; North Pacific; Sea of Okhotsk.

The taxonomic value of the ratio of discal and marginal tentacles in the genus *Corallimorphus* is studied for a collection of specimens from the Sea of Okhotsk, and the findings are discussed.

Introduction

Since the study of the genus *Corallimorphus* was started, the main taxonomic character used to separate species has been the ratio of the number of marginal tentacles to that of the discal ones. Polyps with a marginal:discal (m:d) tentacle ratio of 2:1 and 4:1 collected by the "Challenger" expedition were described as two distinct species, *Corallimorphus rigidus* and *Corallimorphus profundus* respectively (Moseley, 1877a, 1877b; Hertwig, 1882, 1888). This feature remained important in the taxonomy of the genus. For example, Fautin et al. (2002) subdivided the genus *Corallimorphus* into two groups of species: *Corallimorphus rigidus*, *C. ingens*, *C. atlanticus*, *C. denhartogi* (ratio of marginal:discal tentacles 2:1) were referred to the «*rigidus*» group. *C. profundus* and *C. pilatus* (ratio of marginal: discal tentacles comes to 4:1) to the «*profundus*» group. Here we discuss whether this character is of a high taxonomic value or not.

Material and methods

Our work on classification of *Corallimorphus* has been carried out on the base of morphology, nematocysts set as well as symmetry of polyps. Its goal was a revision of the genus. Therefore, a wide range of samples, from nearly all parts of the world ocean, were brought together in the National Natural History Museum, Leiden, The Netherlands. As a first step we restricted ourselves to a study of the symmetry regularities and used a more restricted range of material:

No:1022510230. Vessel "Vityaz", st. 101; 12.09.1949; Sea of Okhotsk, 54°29'N, 147°47'E;
depth: 880900 m, bottom: sandy mud with gravel; Sigsbee trawl. Collector P.V.
Uschakov. In alcohol, probably after formalin fixation.

No:10231 and 10232. Vessel "Novoulyanovsk", st. 71; 2.10.1984; Sea of Okhotsk,
48°54'N, 150°03'E; 1375 m; bottom unknown; big fishing trawl. Collector S.D. Grebelnyi.
In alcohol, probably after Bouin fixation.

- No:10245.** Vessel "Academician Oparin", st. 44; 24.08.1991; Kamchatskiy Proliv (Strait) off Bering I. (Ostrov Beringa), 55°35'N, 165°00'E; 205 m; bottom unknown; Sigsbee trawl. Collector A.V. Smirnov.
- No:10260 and 10261.** Vessel "Academician Oparin", st. 94; 10.09.1991; Kuril Islands , 43°10'N, 146°18'E; 535 m; muddy sand; Sigsbee trawl. Collector A.V. Smirnov. Fixed in formalin.
- No:10262 and 10263.** Vessel "Academician Oparin", st. 42; 24.08.1991; Kamchatskiy Proliv (Strait) off Bering I. (Ostrov Beringa), 55°36'N, 164°53'E; 158 m; bottom unknown; Sigsbee trawl. Collector A.V. Smirnov. Fixed in formalin.
- No:1026410276.** Vessel "Novoulyanovsk", st. 66; 1.10.1984; Sea of Okhotsk, 48°58'N, 147°41'E; 12901270 m; grey mud; big fishing trawl. Collector S.D. Grebelnyi. No: 1026510269 fixed in formalin, No:1027010273 fixed in 4% formalin with picric acid.
- No:10224.** Vessel "Vityaz", st. 101; 12.09.1949; Sea of Okhotsk, 54°29'N, 147°47'E; depth: 880900 m, bottom: sandy mud with gravel; Sigsbee trawl. Collector P.V. Uschakov. In alcohol, probably after formalin fixation.
- No:10234.** Vessel "Novoulyanovsk", st. 154; 26.10.1984; Sea of Okhotsk, 52°24'N, 150°07'E; 10601040 m; clayey mud; big fishing trawl. Collector S.D. Grebelnyi. In alcohol, probably after Bouin fixation.
- No:10244 and 10246.** Vessel "Academician Oparin", st. 44; 24.08.1991; Kamchatskiy Proliv (Strait) off Bering I. (Ostrov Beringa), 55°35'N, 165°00'E; 205 m; bottom unknown; Sigsbee trawl. Collector A.V. Smirnov. Fixed in formalin.
- No:10235** Vessel "Ob'", st. 57; 29.03.1956; Antarctic, Balleny Isls. 64°03'S, 161°59'E; 3000 m; stones and mud; Sigsbee trawl. Collectors P.V. Uschakov and G.M. Belyaev. Fixed in formalin.

In *Corallimorphus*, the arrangement of tentacles on the oral disc, their number, and association in cycles are quite variable. Although such variability does not seem to be a geographic one, we studied mostly specimens from the Sea of Okhotsk and adjacent waters to rule out geography as the source of variation. The Antarctic samples from our collection and those described by our American colleague Dr D. Fautin (1984) could also be quite appropriate for such an investigation. The result of such an examination of Antarctic material undoubtedly would be quite similar to that presented below.

When describing the arrangement of tentacles or pattern of their development in *Corallimorphus*, previous authors used different designations, often referring equally sized tentacles to different cycles. In this paper, we separate the tentacles into cycles in concordance with the symmetry of the body. Symmetry is determined in *Corallimorphus* only by the position of tentacles and flat of the throat. Therefore, we consider the tentacles that are symmetrically disposed and approximately equal in size to be of the same cycle.

Figure 1 gives the scheme of the tentacular arrangement in a large *Corallimorphus* polyp (specimen No:10260, diameter of about 7 cm). In pictures presented in the paper some conventional patterns are used. Discal tentacles of the first and the second cycle are shown connected by bold straight lines. The marginal tentacles and corresponding to them the discal ones of the third cycle are connected by straight thinner lines. The sites of oral disc, where the development of tertiary discal tentacles retards, are marked by dotted triangles. The insertions, the lines of attachment of mesenteries

fused to the oral disc from inside of body cavity, are shown by thin tortuous lines, as they are seen from above through the translucent oral disc.

A body cavity of coral polyps is divided by lamellae of mesenteries into chambers, *endocoels* and *exocoels*. The endocoels are narrow chambers, enclosed by paired mesenteries. The cavities of tentacles open to these endocoels.

In the majority of Corallimorpharia, the tentacles are arranged in distinct radial rows, stretching from the mouth to the margin of the oral disk. However, polyps belonging to the genus *Corallimorphus* have large but not numerous tentacles, and such an arrangement is less distinguishable, because with an endocoel, a marginal and a discal, or only one marginal tentacle can be connected. In the animal in figure 1, due to its perfect preservation, we can trace the correspondence of discal and marginal tentacles to the endocoels. In the other samples, which are in worse condition, it can

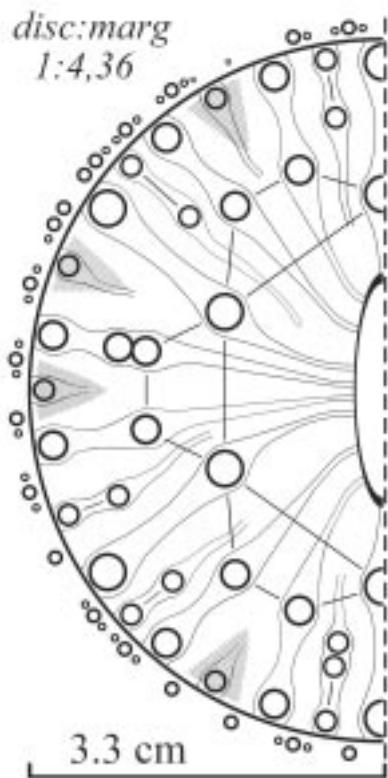


Fig. 1. Scheme showing arrangement of tentacles on oral disc of large *Corallimorphus* polyp, specimen No:10260. The lines of attachment of mesenteries to the oral disc are shown by thin tortuous lines. The sites of oral disc, where the development of tertiary discal tentacles retards, are marked by dotted triangles. For the significance of other graphical symbols, see comments in text.

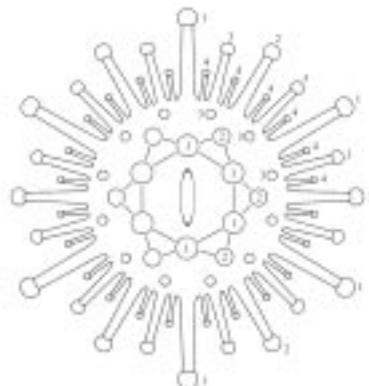


Fig. 2. Scheme showing the arrangement of tentacles in regular hexamerous polyp with four cycles of tentacles. Tentacles of the 1st–4th cycles marked by corresponding Arabic numerals.

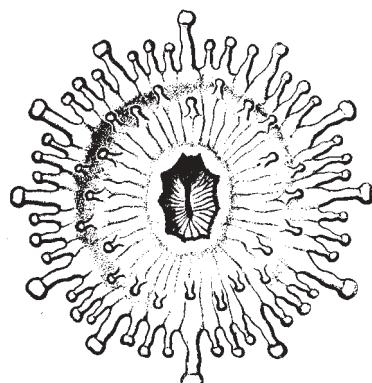


Fig. 3. Type specimen of *Corallimorphus rigidus*. From R. Hertwig, 1882.

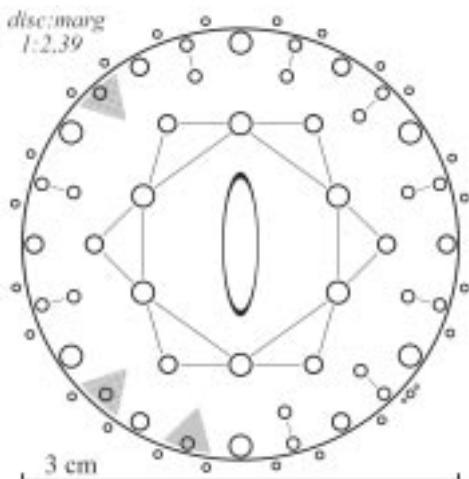


Fig. 4. The arrangement of tentacles on oral disc of specimen No:10235. Three discal tentacles of the third cycle are lacking.

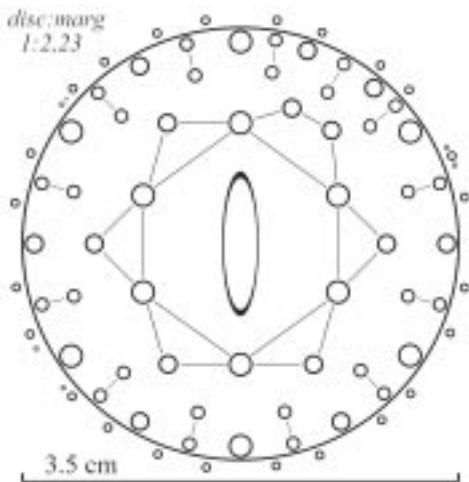


Fig. 5. The arrangement of tentacles on oral disc of specimen No:10264. Third cycle of tentacles is complete. Discal tertiary tentacles are present in all secondary exocoels.

second cycle; all of its big discal tentacles, 6 tentacles of the second cycle, are arranged symmetrically. The same regular hexamerous symmetry of older tentacles disposition is seen in specimen No:10262 (fig. 9), though the third cycle of discal tentacles in both of these polyps is incomplete. There is a lack of four and six discal tentacles of the third cycle, respectively.

In all polyps described so far, the diameter of oral disc is about 1 cm or more, and

be much more difficult. In these samples, in order to divide tentacles into the first, second or third cycle and to match each discal tentacle with the marginal one of the same endocoel, we rely primarily on size and arrangement of the larger tentacles.

Results

Figure 2 shows the constitution of a regular hexamerous polyp with four tentacular cycles. It is in complete concordance with that of the type specimen of *Corallimorphus rigidus*, that seems to be somewhat schematised by Hertwig (1882, fig. 3). The constitution of our specimen No:10235 (fig. 4) being quite of the same kind, but it lacks three discal tentacles of the third cycle.

The next stage of tentacular growth is represented by the specimen No: 10264 (fig. 5). Here, the third cycle of discal tentacles as well as the corresponding marginal ones are complete. Moreover, there is one additional distal tentacle of the second cycle above the upper-right exocoel of the first order.

In the specimen No:10232 (fig. 6), there are four additional discal tentacles of the second cycle, but the development of the third cycle is delayed, and in two secondary exocoels (dotted triangles) tertiary discal tentacles are absent.

The specimen No:10226 (fig. 7) has five additional discal tentacles of the second cycle, and lacks a discal tentacle in the third.

Lastly, specimen No:10231 (fig. 8) has six additional discal tentacles of the first cycle, and 12 tentacles of the second cycle, are arranged symmetrically. The same regular hexamerous symmetry of older tentacles disposition is seen in specimen No:10262 (fig. 9), though the third cycle of discal tentacles in both of these polyps is incomplete. There is a lack of four and six discal tentacles of the third cycle, respectively.

the first and the second cycles of discal tentacles are already complete. Each discal tentacle is accompanied by a marginal one. In addition, at the margin of the oral disk between the neighbouring tentacles of the two first cycles there is always a tentacle of the third cycle. There are three possible ways of further increase of the tentacle number:

1. Insertion of the marginal tentacles of the fourth and fifth cycle at the margin of the disc. The specimen No: 10235 has two tentacles of the 5th cycle (fig. 4); the specimen No:10231 six tentacles of the 5th cycle (fig. 8). Very rarely, between the tentacles of the fifth cycle and those of the preceding ones, there are a few, very small, redundant marginal tentacles, which may be interpreted as the initial tentacles of the sixth cycle. They were found in the animals, which possess the third cycle that includes complete number of both marginal and discal tentacles, specimens No:10261, 10264 (fig. 5), 10265.
2. Insertion of additional discal tentacles, accompanied by large marginal ones in the second cycle.
3. Insertion of discal tentacles of the third cycle nearer to the mouth (these are in addition to the marginal tertiary tentacles that correspond to the exocoels of the second order) These tertiary discal tentacles are neither in all animals (fig. 10) nor every time in all secondary endocoels (fig. 11, one tertiary discal tentacle is present; fig. 7 and 6, one or two tertiary discal tentacles are missing; fig. 5, not one tertiary discal tentacles is omitted). Occasionally some discal tentacles of the fourth cycle may appear (specimen No:10261). Also very seldom, the second and the third cycles may include not one, but two discal tentacles, located above the same endocoel (fig. 1, specimen No:10260). It also should be mentioned, that it is at the same sites of the oral disc where retardation in development of discal tertiary tentacles and the youngest marginal ones are observed (fig. 9, specimen No:10262).

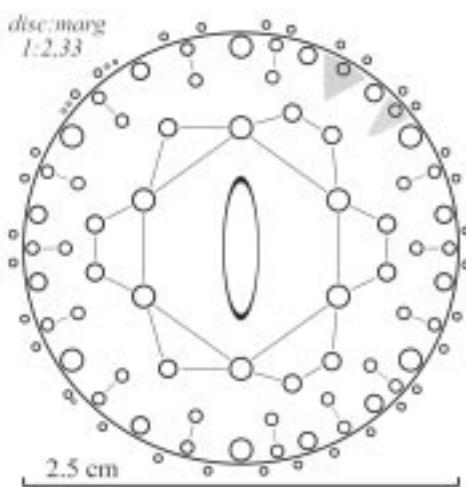


Fig. 6. The arrangement of tentacles on oral disc of specimen No:10232. Two discal tentacles of the third cycle are lacking.

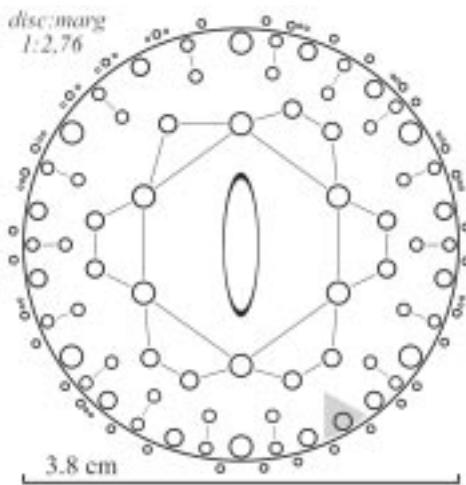


Fig. 7. The arrangement of tentacles on oral disc of specimen No:10226. Only one discal tentacles of the third cycle is lacking.

Occasionally some discal tentacles of the fourth cycle may appear (specimen No:10261). Also very seldom, the second and the third cycles may include not one, but two discal tentacles, located above the same endocoel (fig. 1, specimen No:10260). It also should be mentioned, that it is at the same sites of the oral disc where retardation in development of discal tertiary tentacles and the youngest marginal ones are observed (fig. 9, specimen No:10262).

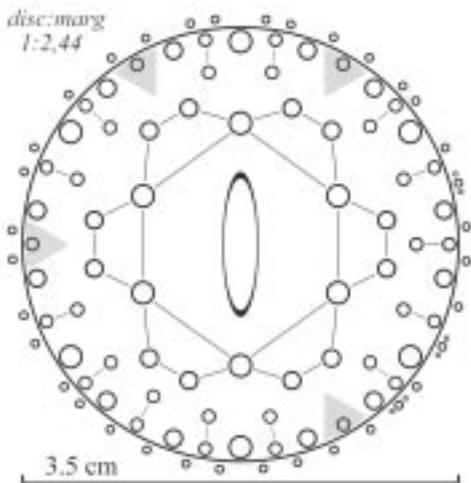


Fig. 8. The arrangement of tentacles on oral disc of specimen No:10231. Four discal tentacles of the third cycle are lacking.

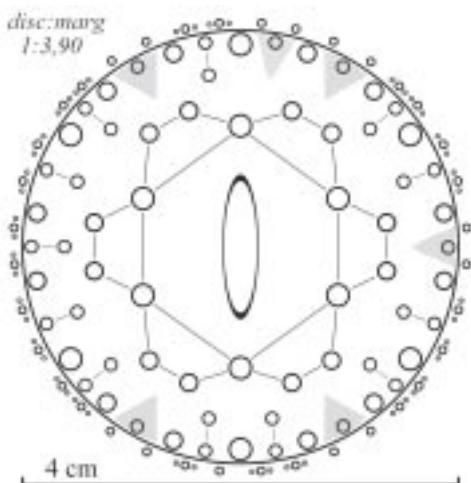


Fig. 9. The arrangement of tentacles on oral disc of specimen No:10262. Six discal tentacles of the third cycle are lacking.

Our well-preserved specimens show that the first cycle of discal tentacles is always regular and always includes only six tentacles (figs. 4–12). As concerns the second cycle, there may be more tentacles, seven large discal tentacles (fig. 5), ten (fig. 6), eleven (figs 7, 11), or twelve tentacles (figs 8–10).

The introduction of some additional tentacles into the second cycle destroys the hexamerous symmetry of the body. However, such an introduction is known not only in Corallimorpharians, which quite often deviate from regular symmetry, but also occurs in the actiniarian families Actiniidae, Actinostolidae, and others (Carlgren, 1921; Grebelnyi, 1982). Incorporation of additional mesenterial pairs together with additional tentacles placed above their endocoels changes the multiplicity of symmetry. As a result, at definite stage hexamerous sea anemones become octo- or decamerous.

In *Corallimorphus* polyps, the addition of one, two, three, four, or five discal tentacles to the second cycle destroys the usual symmetry. Nevertheless, polyps that add one more (the sixth additional) discal tentacle restore hexamerous symmetry: all the 12 tentacles of the second cycle, being of an approximately equal size, are disposed by two above each exocoel of the first order. Therefore those animals restore the regular hexamerous symmetry that may be lost [it keeps still a little disrupted] disrupted by the asynchronous development of youngest marginal tentacles.

Discussion

If we used the ratio of marginal: discal tentacles (for values see table 1) for intra-generic classification of *Corallimorphus* we would have to establish the taxonomic position of the samples studied as follows:

- a) approximately one third of the specimens that possess m:d of about 2:1 would belong to the «*rigidus*» group (animals No:10264, fig. 5; No:10232, fig. 6; No:10269; No:10235, fig. 4; No:10265; No:10231, fig. 8);
- b) another one third of them, with the ratio 3:1, to the «*profundus*» group (animals No:10226, fig. 7; No:10225; No:10266; No:10263; No:10261);
- c) four polyps, which are of m:d close to 4:1, would have some intermediate position (animals No:10224; No:10262, fig. 9; No:10260, fig. 1; No:10245)
- d) the taxonomic position of three specimens of m:d 4,72:1; 5,68:1 and 6,66:1, consequently, would be quite indefinite (animals No:10234, fig. 10; No:10244; and No:10246, fig. 11).

Table 1. The ratio of marginal:discal tentacles of the studied material.

<i>Ratio of marginal : discal tentacles</i>	<i>Specimen Number</i>
<i>m:d = 2,23:1</i>	No:10264
<i>2,33:1</i>	No:10232
<i>2,35:1</i>	No:10269
<i>2,37:1</i>	No:10265
<i>2,39:1</i>	No:10235
<i>2,44:1</i>	No:10231
<i>2,76:1</i>	No:10226
<i>2,84:1</i>	No:10225
<i>3,00:1</i>	No:10266
<i>3,30:1</i>	No:10263
<i>3,41:1</i>	No:10261
<i>3,55:1</i>	No:10224
<i>3,90:1</i>	No:10262
<i>4,36:1</i>	No:10260
<i>4,50:1</i>	No:10245
<i>4,72:1</i>	No:10234
<i>5,68:1</i>	No:10244
<i>6,66:1</i>	No:10246

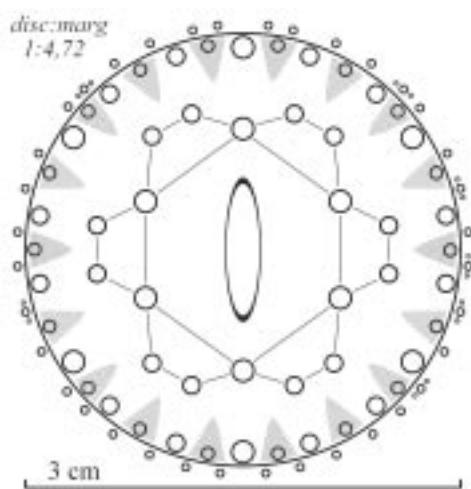


Fig. 10. The arrangement of tentacles on oral disc of specimen No:10234. Not one discal tentacles of the third cycle is present.

The inclusion of additional discal tentacles to the second cycle has little influence on ratio of marginal:discal tentacles, because with every discal tentacle a marginal one is unavoidably added. On the other hand, the formation of the third cycle of tentacles can considerably change this ratio. If discal tentacles of the third cycle develop almost synchronously with marginal ones, the ratio of marginal:discal tentacles remains

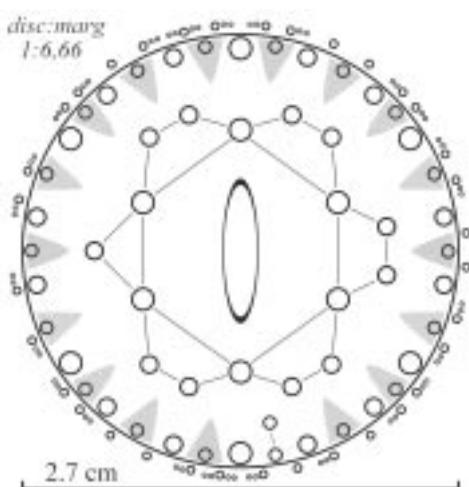


Fig. 11. The arrangement of tentacles on oral disc of specimen No:10246. Only one discal tentacles of the third cycle is present.

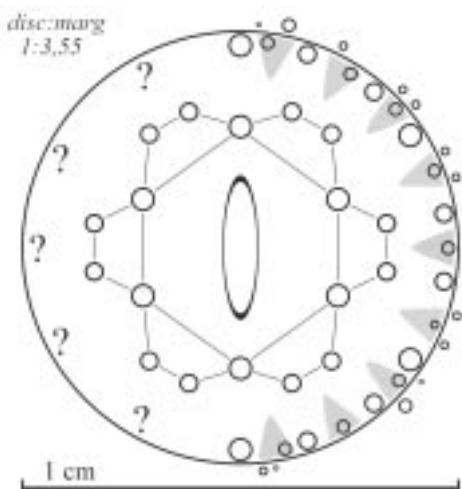


Fig. 12. The arrangement of tentacles on oral disc of specimen No:10224. Due to the bad preservation of material marginal tentacles were not studied and shown in the left half of picture.

ley (1877), who described the genus *Corallimorphus* and the first couple of its species, was not sure about the taxonomic value of the marginal : discal tentacles ratio. Nowadays, as variability of these forms has been studied enough, it is time to accept that being quite traditional, the character is rather useless in intrageneric classification.

around 2:1 or 3:1 (specimens No:10264, 10232, 10226, 10231; figs. 5–8). Only in large, and probably very old polyps, with well developed discal tentacles of the third cycle and nearly complete fourth and fifth cycle of marginal tentacles, does the number of marginal tentacles exceeds the number of the discal ones threefold or more (specimens No:10262, 10260; fig. 9 and 1). When the development of discal tertiary tentacles fall behind the development of marginal ones [= marginal tertiary tentacles], the ratio of marginal:discal tentacles can reach 5:1 or even 6:1 (specimens No:10234, fig. 10; 10244; 10246, fig. 11).

Retardation in development of the discal tentacles of the third cycle does not correlate very much with the size of body; it is seen both in small specimens (No:10224, fig. 12: diameter of oral disc about 1 cm) and in rather large ones (No:10234, fig. 10, and No:10244: diameter about 3 cm).

Thus, in the genus *Corallimorphus* the ratio of marginal:discal tentacles seems to be highly variable. As one can see, it can be influenced either by insertion of additional tentacles into older cycles or by the development of the latest (the fifth or the sixth) tentacular cycle. As it was mentioned above, both of the transformations being known in Actiniidae, Actinostolidae, and some other families of sea anemones, are never considered to be an indicator of separate species. According to all the taxonomists, either octomorous specimens of *Somphia*, or decamorous specimens of *Urticina* are conspecific to the hexamerous ones. The symmetry of corallimorpharians, discussed in this paper, varies even more.

It should be pointed out that Moseley

Acknowledgements

This research was supported by a NWO visitors grant. The authors started this work in 1995–96, however, the final text and illustrations were reworked only in the autumn 2002 by the second author.

References

- Carlgren O., 1921. Actiniaria. Part I.— The Danish Ingolf-Exped., Copenhagen, v. 5, pt. 9, 241 p.
- Fautin, D.G., 1984. More Antarctic and Subantarctic sea anemones (Coelenterata: Corallimorpharia and Actiniaria). In: Kornicker, L.S. (ed.), Biology of the Antarctic Seas, XVI.— Antarctic Research Series (American Geophysical Union) 5 (41) 1: 1–42.
- Fautin, D.G., White, T.R. & Pearson K.E., 2002. Two new species of deep-water Corallimorpharia (Cnidaria: Anthozoa) from the Northeast Pacific, *Corallimorphus denhartogi* and *C. pilatus*.— Pac. Sci. 56 (2): 113–124.
- Grebelnyi, S.D., 1982. The symmetry of Actiniaria and its importance for classification of Anthozoa. In: Beniaminson, T.S., Krasnov, E.V. et al. (eds), Biology of coral reefs.— Vladivostok: 101–123 (in Russian).
- Grebelnyi, S.D., 1982. The same on Internet. [Grebelnyi <http://deuteron.kgs.ukans.edu/KWRC/anemone2/chapters.cfm?referenceid=526&type=Chapter>]
- Hertwig, R., 1882. Report of the Actiniaria dredged by H. M. S. 'Challenger' during the years 1873–76. Report on the Scientific Results of the Voyage of the H. M. S. 'Challenger' during the years 1873–1876 (Zoology), Sci. 6 (1).— London, 134 p., pl. 1–14.
- Hertwig, R., 1888. Report of the Actiniaria dredged by H. M. S. 'Challenger' during the years 1873–76. Supplement. Report on the Scientific Results of the Voyage of the H. M. S. 'Challenger' during the years 1873–1876, Sci. Zoology 6 (73).— London, 56 p., pl. 1–4.
- Moseley, H.N., 1877a. On new forms of Actiniaria dredged in the deep sea; with a description of certain pelagic surface-swimming species. — Trans. Linn. Soc. London 2, (1) Zool.: 295–305, pl. 45.
- Moseley, H.N., 1877b. On the colouring-matters of various animals, and especially of deep-sea forms dredged by H.M.S. 'Challenger'.— Quart. J. Microsc. Sci. New Ser. 17.

