

Key to the common shallow-water brittle stars (Echinodermata: Ophiuroidea) of the Gulf of Mexico and Caribbean Sea

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ABSTRACT

A key is given for 85 species of ophiuroids from the Gulf of Mexico and Caribbean Sea covering a depth range from the intertidal down to 30 m. Figures highlighting important anatomical features associated with couplets in the key are provided.

INTRODUCTION

The Caribbean region is one of the major coral reef zoogeographic provinces and a region of intensive human use of marine resources for tourism and fisheries (Aide and Grau, 2004). With the world-wide decline of coral reefs, and deterioration of shallow-water marine habitats in general, ecological and biodiversity studies have become more important than ever before (Bellwood et al., 2004). Ecological and biodiversity studies require identification of collected specimens, often by biologists not specializing in taxonomy, and therefore identification guides easily accessible to a diversity of biologists are necessary.

The Ophiuroidea is the most diverse class of echinoderms with numerous representatives found in all the primary habitats (sea grass, coral reef, mangrove, sandy bottom) of the shallow waters of the Gulf of Mexico and Caribbean Sea. Most genera and species found in the region were first described or revised prior to 1970 in works by Müller and Troschel, Lyman, Ljungman, Lütken, Koehler, H.L. Clark, A.H. Clark, Thomas, and A.M. Clark (see Hendler et al., 1995; Pomory, 2004 for extensive bibliographies). However, new species are still being discovered (e.g. Hotchkiss, 1982; Hendler and Miller, 1984; Hendler and Turner, 1987; Hendler, 1988, 1995, 2005; Schoppe, 1996). Useful synopses include Lyman (1883), Koehler (1914), H.L. Clark (1915, 1918, 1919, 1933), Caso (1951), A.H. Clark (1954), Hendler and Peck (1988), Hendler et al. (1995), Hendler and Pawson (2000). Ophiuroids have never been monographed. The literature base of original descriptions is widespread in a great variety of journals. Hendler et al. (1995) is the most recent identification guide for Florida and the Bahamas which has excellent descriptions and photographs, but does not have a key to species, does not include several species from the Gulf of Mexico and southern Caribbean, and is missing species described since 1995; thus no recent key to the common shallow-water species exists.

MATERIALS AND METHODS

The key is limited to the Gulf of Mexico and Caribbean Sea to northern South America for adult forms of species normally found from the intertidal zone to 30 m depth. The depth limitation is based on defining "shallow-water" in relation to depth zonation for seagrasses (McMillan, 1980; den Hartog, 1970; Duarte, 2002; Larkum et al., 2006), end of the fore-reef zone for coral reefs (Goreau, 1959; Rützler and Macintyer, 1982; Huston, 1985), coastal zone areas in general (Yáñez-Arancibia and Day, 2004), practical depth limits for SCUBA which is used for ecological censuses in areas where dredging and coring can not be utilized, and coverage by previous works (Clark, 1933; Hendler et al., 1995). Juvenile and adult ophiuroids of the same species have different characteristics especially in the disk covering, arm spine number, and often habitat preference. A key including all possible changes would need to be several keys for successive time points in the growth curve which is beyond to scope of the present effort.

The key is based on specimens collected by the author and on literature descriptions. While many Caribbean species have geographic ranges that continue further south, the key does not extend to southern Brazil, a region eminently covered by the numerous works of L.R. Tommasi (e.g. Tommasi, 1970), which has many unique species not reported from the Caribbean. The key has undergone several preliminary revisions over the past five years based on the outcome of trials made by numerous students with varying levels of experience working on material collected in the Florida Keys. The revisions have been designed to avoid some

confusing dichotomies in previously published keys. This has led to the rearrangement of couplets and use of characteristics that are not strictly hierarchical in relation to the higher classification scheme currently in use. While professional taxonomists may not fully approve of this type of organization, it seems to work better for a wider audience of biologists interested in identifying marine organisms. The hierarchical classification with annotations is presented before the key.

The following are the main characters used in identification of ophiuroids based on adult specimens as viewed under a stereo dissecting microscope (Figs. 1-3 and glossary of terms in appendix 1). In some cases the disk features are more obvious on dry specimens lit from one side. The most common genera are illustrated in detail for comparative purposes (Figs. 4-9). Simplified stick-figure diagrams are given to facilitate understanding some of the more important couplets in the key (Figs. 10, 11).

Aboral (dorsal) Side of Disk: 1. disk covered with skin, scales, spines, or granules; 2. disk diameter; 3. radial shields exposed or covered, and radial shield shape, size and placement.

Oral (ventral) Side of Disk: 1. number of genital (bursal) slits per interbrachial area; 2. covering of interbrachial area the same or different as aboral side of disk; 3. presence or absence, number and shape of oral papillae; 4. presence or absence of dental papillae; 5. adoral shields exposed or covered, and adoral shield shape and placement; 6. shape of oral shields.

Arms: 1. number; 2. presence or absence of bifurcations; 3. ability to coil along arm axis; 4. length compared to disk diameter.

Individual Arm Segments: 1. shape and division of aboral arm plates; 2. presence or absence of accessory aboral arm plates; 3. shape, size and number of arm spines per side (lateral) arm plate; 4. shape of oral arm plates; 5. number and shape of podial (tentacle) scales. The first few arm segments close to the disk may be different compared to the rest of the arm and segments at the distal end of the arm may be aberrant due to regeneration or small size of segments, so most descriptions are based on the middle section of the arm.

ANNOTATED LIST OF SPECIES

Order Euryalida

Family Gorgonocephalidae

Asteroporpa annulata Örsted & Lütken, 1856

habitat: wrapped around gorgonians or other up-right organisms or structure

asymptotic size: disk diameter ~ 20 mm

description/illustration references: Hendler et al., 1995

notes: depth distribution is typically deeper water with 30 m representing upper limit

Astrocanium herrerae (A.H. Clark, 1919)

habitat: reef

asymptotic size: disk diameter ~ 50 mm

description/illustration references: A.H. Clark, 1919

Astrogordius cacaoticus (Lyman, 1874)

habitat: reef

asymptotic size: disk diameter ~ 30 mm

description/illustration references: Lyman, 1874 as *Astrophyton cacaoticum*

Astrophyton muricatum (Lamarck, 1816)

habitat: reef

asymptotic size: disk diameter ~ 70 mm

description/illustration references: Hendler et al., 1995

Schizostella bifurcata A.H. Clark, 1952

habitat: reef on gorgonians

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Hendler et al., 1995

Order Ophiurida

Family Ophiomyxidae

Ophioblenna antillensis Lütken, 1859

habitat: reef, rubble

asymptotic size: disk diameter ~ 20 mm

description/illustration references: Hendler et al., 1995

Ophiobyrsa serpens Lyman, 1883

habitat: reef

asymptotic size: disk diameter ~ 20 mm

description/illustration references: Lyman, 1883

notes: originally described from much deeper water, with reports from deep reef areas

Ophiomyxa flaccida (Say, 1825)

habitat: reef, rubble

asymptotic size: disk diameter ~ 25 mm

description/illustration references: Hendler et al., 1995

Family Hemieuryalidae

Sigsbeia conifera Koehler, 1914

habitat: reef

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Hendler et al., 1995

Family Ophiocomidae

Ophiocoma echinata (Lamarck, 1816)

habitat: reef, rubble

asymptotic size: disk diameter ~ 30 mm

description/illustration references: Hendler et al., 1995

Ophiocoma paucigranulata Devaney, 1974

habitat: reef, rubble

asymptotic size: disk diameter ~ 20 mm

description/illustration references: Devaney, 1974; Hendler et al., 1995

Ophiocoma pumila Lütken, 1859

habitat: reef, rubble

asymptotic size: disk diameter ~ 15 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

Ophiocoma wendtii Müller & Troschel, 1842

habitat: reef, rubble

asymptotic size: disk diameter ~ 35 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

- Ophiocomella ophiactoides* (H.L. Clark, 1901)
 habitat: reef, rubble
 asymptotic size: disk diameter ~ 5 mm
 description/illustration references: Hendler et al., 1995
- Ophiopsila hartmeyer* Koehler, 1913
 habitat: reef, sand
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: Hendler et al., 1995
- Ophiopsila polysticta* H.L. Clark, 1915
 habitat: reef, sand
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: H.L. Clark, 1915
- Ophiopsila riisei* Lütken, 1859
 habitat: reef, rubble, mangrove, algae
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: Hendler et al., 1995
- Ophiopsila vittata* H.L. Clark, 1918
 habitat: sand
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: Hendler et al., 1995
- Family Ophionereididae
- Ophionereis dolabriformis* John & Clark, 1954
 habitat: sand
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: John & Clark, 1954
 notes: reported from the South American coast
- Ophionereis olivacea* H.L. Clark, 1901
 habitat: algae
 asymptotic size: disk diameter ~ 5 mm
 description/illustration references: Hendler et al., 1995
- Ophionereis reticulata* (Say, 1825)
 habitat: reef, rubble
 asymptotic size: disk diameter ~ 15 mm
 description/illustration references: Hendler et al., 1995; Pomory, 2004
- Ophionereis squamulosa* Koehler, 1914
 habitat: reef, rubble
 asymptotic size: disk diameter ~ 5 mm
 description/illustration references: Hendler et al., 1995
- Ophionereis vittata* Hendler, 1995
 habitat: deep reef
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: Hendler et al., 1995; Hendler, 1995

Family Ophiotrichidae

Ophiotrix angulata (Say, 1825)

habitat: reef, rubble, encrusting community, sea grass, sponges, oyster, algae

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

Ophiotrix brachyactis H.L. Clark, 1915

habitat: reef, rubble

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Hendler et al., 1995

Ophiotrix cimar Hendler, 2005

habitat: reef, rubble

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler, 2005

notes: reported from the Central American coast

Ophiotrix hartfordi A.H. Clark, 1939

habitat: reef, rubble

asymptotic size: disk diameter ~ 5 mm

description/illustration references: A.H. Clark, 1939, Hendler et al., 1995

notes: only reported once

Ophiotrix lineata Lyman, 1860

habitat: sponges

asymptotic size: disk diameter ~ 15 mm

description/illustration references: Hendler et al., 1995

Ophiotrix platyactis H.L. Clark, 1939

habitat: reef, rubble

asymptotic size: disk diameter ~ 8 mm

description/illustration references: H.L. Clark, 1939, Hendler et al., 1995

notes: only reported once

Ophiotrix oerstedii Lütken, 1856

habitat: reef, rubble, sponges

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995

Ophiotrix stri Hendler, 2005

habitat: reef, rubble

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler, 2005

notes: reported from the Central American coast

Ophiotrix suensonii Lütken, 1856

habitat: sponges, gorgonians

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

Ophiotrix synoecina Schoppe, 1996

habitat: shallow rock areas under the sea urchin *Echinometra lucunter*

asymptotic size: disk diameter ~ 7 mm

description/illustration references: Schoppe, 1996; Hendler, 2005

notes: reported from Colombia

Family Ophiactidae

Hemipholis elongata (Say, 1825)

habitat: sand/mud

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

Ophiactis algicola H.L. Clark, 1933

habitat: algae, encrusting community

asymptotic size: disk diameter ~ 2 mm

description/illustration references: Hendler et al., 1995

Ophiactis lymani Ljungman, 1871

habitat: rubble, sand, algae

asymptotic size: disk diameter ~ 5 mm

description/illustration references: A.M. Clark, 1955

Ophiactis muelleri Lütken, 1856

habitat: rubble, sand, algae

asymptotic size: disk diameter ~ 5 mm

description/illustration references: H.L. Clark, 1915, Hendler et al., 1995

Ophiactis notabilis H.L. Clark, 1939

habitat: reef, rubble

asymptotic size: disk diameter ~ 5 mm

description/illustration references: H.L. Clark, 1939

notes: only reported once

Ophiactis quinqueradialia Ljungman, 1871

habitat: reef, encrusting community, sponges

asymptotic size: disk diameter ~ 15 mm

description/illustration references: Hendler et al., 1995

Ophiactis rubropoda Singletery, 1973

habitat: encrusting community

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Hendler et al., 1995

notes: reported from Florida U.S.A. southeast coast, see *Ophiactis simplex**Ophiactis savignyi* (Müller & Troschel, 1842)

habitat: reef, rubble, encrusting community, algae

asymptotic size: disk diameter ~ 4 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

notes: world wide distribution

Ophiactis simplex (Le Conte, 1851)

habitat: rock jetty among encrusting organisms along Texas, U.S.A. coast

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Christensen, 2004

notes: *Ophiactis simplex* is typically found in the Pacific. The occurrence in Texas is probably a relatively recent exotic introduction as Pomory (2004) did not find specimens in this area from collections made between 1987 and 1990. Christensen and Christensen (2003), Christensen (2004), and Christensen (pers. comm.) indicate that there is no morphological difference and little molecular difference between *Ophiactis simplex* and *Ophiactis rubropoda* suggesting they are the same species. If they are the same this would indicate an exotic introduction to the Miami, Florida, U.S.A. area sometime in the late 1960s. I have listed both species separately until further work is done on them, but both key out to the same spot in the present dichotomous key.

Family Amphiuroidae

Amphiodia atra (Stimpson, 1852)

habitat: sand/mud

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

Amphiodia guillermosoberoni Caso, 1979

habitat: sand/mud

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Caso, 1979

notes: reported from southern Gulf of Mexico, Mexican coast

Amphiodia planispina (Martens, 1867)

habitat: sand/mud

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995

Amphiodia pulchella (Lyman, 1869)

habitat: sand/mud

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

Amphiodia trychna H.L. Clark, 1918

habitat: sand/mud

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995

Amphioplus coniertodes H.L. Clark, 1918

habitat: sand/mud

asymptotic size: disk diameter ~ 7 mm

description/illustration references: Hendler et al., 1995

Amphioplus sepultus Hendler, 1995

habitat: sand/mud

asymptotic size: disk diameter ~ 9 mm

description/illustration references: Hendler et al., 1995; Hendler, 1995

- Amphioplus thrombodes* H.L. Clark, 1918
 habitat: sand/mud
 asymptotic size: disk diameter ~ 8 mm
 description/illustration references: Hendler et al., 1995
- Amphipholis gracillima* (Stimpson, 1852)
 habitat: sand/mud
 asymptotic size: disk diameter ~ 8 mm
 description/illustration references: Hendler et al., 1995; Pomory, 2004
- Amphipholis januarii* Ljungman, 1867
 habitat: sand/mud, rubble
 asymptotic size: disk diameter ~ 5 mm
 description/illustration references: Hendler et al., 1995
- Amphipholis squamata* (Delle Chiaje, 1828)
 habitat: reef, rubble, sand/mud, encrusting community, algae
 asymptotic size: disk diameter ~ 5 mm
 description/illustration references: Hendler et al., 1995
- Amphiura fibulata* Koehler, 1913
 habitat: sand/mud
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: Hendler et al., 1995
- Amphiura (Ophionema) intricata* (Lütken, 1869)
 habitat: sand/mud
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: Hendler et al., 1995
- Amphiura palmeri* Lyman, 1882
 habitat: sand/mud
 asymptotic size: disk diameter ~ 8 mm
 description/illustration references: Hendler et al., 1995
- Amphiura stimpsonii* Lütken, 1859
 habitat: reef, rubble
 asymptotic size: disk diameter ~ 5 mm
 description/illustration references: Hendler et al., 1995
- Ophiocnida scabriuscula* (Lütken, 1859)
 habitat: sea grass, rubble
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: Hendler et al., 1995
- Ophionephtys limicola* Lütken, 1869
 habitat: sand/mud
 asymptotic size: disk diameter ~ 15 mm
 description/illustration references: Hendler et al., 1995
- Ophiophragmus cubanus* (A.H. Clark, 1917)
 habitat: sand/mud, sea grass
 asymptotic size: disk diameter ~ 15 mm
 description/illustration references: Hendler et al., 1995

Ophiophragmus filograneus (Lyman, 1875)

habitat: sand/mud, sea grass in bays

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995

notes: reported from Florida

Ophiophragmus moorei Thomas, 1965

habitat: sand/mud

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Thomas, 1965; Pomory, 2004

notes: reported from northern Gulf of Mexico

Ophiophragmus pulcher H.L. Clark, 1918

habitat: sand/mud, rubble, sea grass

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995

Ophiophragmus riisei (Lütken, 1859)

habitat: sand/mud

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995

Ophiophragmus septus (Lütken, 1859)

habitat: sand/mud

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Hendler et al., 1995

Ophiophragmus wurdemanii (Lyman, 1860)

habitat: sand/mud

asymptotic size: disk diameter ~ 10 mm

description/illustration references: Thomas, 1962; Thomas, 1965

Ophiostigma isocanthum (Say, 1825)

habitat: sand/mud, rubble, sea grass

asymptotic size: disk diameter ~ 7 mm

description/illustration references: Hendler et al., 1995; Hendler, 1995; Pomory, 2004

Ophiostigma siva Hendler, 1995

habitat: reef, rubble, algae

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Hendler et al., 1995; Hendler, 1995; Pomory, 2004

Family Ophiodermatidae

Ophioderma anitae Hotchkiss, 1982

habitat: reef, rubble

asymptotic size: disk diameter ~ 20 mm

description/illustration references: Hotchkiss, 1982

Ophioderma appressum (Say, 1825)

habitat: reef, rubble, sea grass

asymptotic size: disk diameter ~ 25 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

- Ophioderma brevicaudum* Lütken, 1856
 habitat: reef, rubble, sea grass
 asymptotic size: disk diameter ~ 20 mm
 description/illustration references: Hendler et al., 1995
- Ophioderma brevispinum* (Say, 1825)
 habitat: reef, rubble, sea grass
 asymptotic size: disk diameter ~ 15 mm
 description/illustration references: Hendler et al., 1995; Pomory, 2004
- Ophioderma cinereum* Müller & Troschel, 1842
 habitat: reef, rubble
 asymptotic size: disk diameter ~30 mm
 description/illustration references: Hendler et al., 1995
- Ophioderma ensiferum* Hendler & Miller, 1984
 habitat: deep reef
 asymptotic size: disk diameter ~ 20 mm
 description/illustration references: Hendler and Miller, 1984
- Ophioderma guttatum* Lütken, 1859
 habitat: reef, rubble
 asymptotic size: disk diameter ~ 45 mm
 description/illustration references: Hendler et al., 1995
- Ophioderma januarii* Lütken, 1856
 habitat: reef, sand, sea grass
 asymptotic size: disk diameter ~ 20 mm
 description/illustration references: Tommasi, 1970
 notes: reported from South American coast
- Ophioderma phoenium* H.L. Clark, 1918
 habitat: reef, rubble
 asymptotic size: disk diameter ~ 25 mm
 description/illustration references: Hendler et al., 1995
- Ophioderma rubicundum* Lütken, 1856
 habitat: reef, rubble
 asymptotic size: disk diameter ~ 25 mm
 description/illustration references: Hendler et al., 1995; Pomory, 2004
- Ophioderma squamosissimum* Lütken, 1856
 habitat: reef
 asymptotic size: disk diameter ~ 45 mm
 description/illustration references: Hendler et al., 1995; Pomory, 2004
- Ophiurochaeta littoralis* (Koehler, 1913)
 habitat: reef
 asymptotic size: disk diameter ~ 10 mm
 description/illustration references: Devany, 1974
- Family Ophiolepididae
- Ophiolepis elegans* Lütken, 1859
 habitat: sand
 asymptotic size: disk diameter ~ 20 mm
 description/illustration references: Hendler et al., 1995; Pomory, 2004

Ophiolepis gemma Hendler & Turner, 1987

habitat: reef, algae

asymptotic size: disk diameter ~ 7 mm

description/illustration references: Hendler et al., 1995

Ophiolepis impressa Lütken, 1859

habitat: reef, rubble, algae

asymptotic size: disk diameter ~ 20 mm

description/illustration references: Hendler et al., 1995; Pomory, 2004

Ophiolepis kieri Hendler, 1979

habitat: rubble

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Hendler, 1979; Hendler, 1988

Ophiolepis paucispina (Say, 1825)

habitat: rubble, sea grass, sand, algae

asymptotic size: disk diameter ~ 5 mm

description/illustration references: Hendler et al., 1995

Ophiolepis pawsoni Hendler, 1988

habitat: deep reef

asymptotic size: disk diameter ~ 20 mm

description/illustration references: Hendler, 1988

KEY

Fig. 10

1a. Arms bifurcate beyond disk (family Gorgonocephalidae in part) - 2.

1b. Arms unbranched - 5.

2a. 7 arms leave disk; 1-2 bifurcations approximately 1/3 the distance along each arm - *Schizostella bifurcata*.

2b. 5 arms leave disk; multiple bifurcations along each arm typically starting near edge of disk (basket stars) - 3.

from 2b, Fig. 10

3a. 1-2 madreporites - *Astrophyton muricatum*.

3b. 5 madreporites - 4.

from 3b

4a. Arm spines occur starting distal to second bifurcation of arms - *Astrocaneum herrerae*.

4b. Arm spines occur starting proximal to second bifurcation of arms - *Astrogordius cacaoticus*.

from 1b, Fig. 10

5a. Arms capable of curling along entire arm axis forming tight coils (usually observed even in preserved specimens as curling is often a response to disturbance); commonly found wrapped around soft or hard corals - 6.

5b. Arms not capable of forming tight coils along entire arm axis, although arm tips may curl slightly, arms mainly move side to side; commonly found in algae, mangroves, sand, sea grass, rubble, reef crevices or sponges - 7.

from 5a, Fig. 10

6a. Arms and disk covered by raised ridges (1-2 mm high, 1 mm wide) giving arms a corrugated appearance; area between ridges (3-5 mm between ridges) covered with flattened granules; distinct aboral disk scales and arm plates not visible; usually found deeper than 30 m on gorgonians (family Gorgonocephalidae in part) - *Asteroporpa annulata*.

6b. Aboral disk covered with large scales and large radial shields; aboral and oral arm plates distinct and separated from one another by large side arm plates; commonly found on hydrocorals and hard corals (family Hemieuryalidae) - *Sigsbeia conifera*.

from 5b, Fig. 1

7a. Aboral disk covered with thick skin, often with mucus coating when alive; very distal ends of radial shields may be apparent under skin; aboral side of arms covered with skin, but skin may be thin allowing underlying plates to show through (family Ophiomyxidae) - 8.

7b. Aboral disk usually covered with granules, scales, and/or spines; aboral side of arms usually with plates; rarely either disk or arms with thin skin; if disk covered with thin skin, narrow radial shields completely exposed on disk and arms with plates; if arms covered with skin, disk with scales, spines or granules - 10.

from 7a, Fig. 10

- 8a.** Podial scales present; 6-7 arm spines per side arm plate - *Ophioblenna antillensis*.
8b. Podial scales absent; 3-6 arm spines per side arm plate - 9.

from 8b

- 9a.** End of radial shields visible in skin with small spines; 3 arm spines per side arm plate; oral papillae spine-like, without serrated margins - *Ophiobyrsa serpens*.
9b. End of radial shields visible in skin without small spines; 4-6 arm spines per side arm plate; oral papillae triangular shaped with translucent serrated margins - *Ophiomyxa flaccida*.

from 7b, Fig. 2

Note for couplet 10: see Appendix 1 and Fig. 2 for distinction between oral papillae, dental papillae and teeth on the jaw.

- 10a.** Both oral and dental papillae present (family Ophiocomidae) - 11.
10b. Either oral or dental papillae present, not both, oral papillae may be restricted to distal corners of jaw - 19.

from 10a, Figs. 1, 2, 10

- 11a.** 2 podial scales per podial pore with the lateral scale very narrow, short, spine-like and the medial scale much longer, about the length of an arm segment, flattened and ciliated; aboral disk covered with very small scales or appearing to have naked skin, although narrow radial shields should be obvious (genus *Ophiopsila*, Fig. 4) - 12.
11b. 1-2 podial scales per podial pore that are oval in shape, similar in size, and just large enough to cover podial pores; aboral disk covered with granules - 15.

from 11a

- 12a.** Aboral disk covered with small scales, usually with large blotches of colour - 13.
12b. Aboral disk appears to be covered by naked skin, usually speckled with tiny dots - 14.

from 12a, Fig. 3

- 13a.** Arm spines sharply pointed, middle arm spines similar in length to aboral arm spines - *Ophiopsila polysticta*.
13b. Arm spines bluntly rounded, middle arm spines shorter than aboral arm spines; disk with orange-yellow blotches; may have a darker diffuse stripe running the length of the arms on aboral side - *Ophiopsila hartmeyeri*.

from 12b

- 14a.** Disk colour blue-gray speckled with small dark black dots on aboral and oral side; black dots on aboral and oral side of arms - *Ophiopsila riisei*.
14b. Disk colour yellow-gray speckled with small orange-brown dots; two distinct thin stripes running the length of the arms on aboral side, one stripe near each lateral edge of aboral arm plates; no dots on oral side of arms - *Ophiopsila vittata*.

from 11b

- 15a.** 6 arms; disk < 8 mm diameter - *Ophiocomella ophiactoides*.
15b. 5 arms; disk > 8 mm diameter (genus *Ophiocoma*, Fig. 4) - 16.

from 15b, Fig. 10

16a. Same number of arm spines on each side arm plate of an arm segment (e.g. 4 on one side and 4 on the other side of the same arm segment) - 17.

16b. Different number of arm spines on each side arm plate of an arm segment (e.g. 3 on one side and 4 on the other side of the same arm segment) - 18.

from 16a, Figs. 2, 10

17a. 1 podial scale per podial pore on most arm segments away from disk; granules near edge of disk elongate rather than spherical; arm spines 3-4 times longer than the length of an arm segment; disk < 15 mm diameter and light tan in colour - *Ophiocoma pumila*.

17b. 2 podial scales per podial pore on most arm segments away from disk; granules absent near radial shield area and on oral side of disk; arm spines 4-5 times longer than the length of an arm segment; disk > 15 mm diameter and dark brown in colour - *Ophiocoma paucigranulata*.

from 16b, Figs. 3, 10

18a. 1 podial scale per podial pore on most arm segments away from disk; arm spines 4-5 times longer than the length of an arm segment, with slightly spatulate ends; aboral side of disk and arms coloured dark brown-black, oral side of arms coloured rust-orange due to podia - *Ophiocoma wendtii*.

18b. 2 podial scales per podial pore on most arm segments away from disk; arm spines 2-3 times longer than the length of an arm segment and bluntly conical or cigar shaped; aboral side usually coloured some shade of brown with a great variety of light-dark mottling on disk, oral side of arms coloured whitish due to clear podia - *Ophiocoma echinata*.

from 10b, Figs. 2, 3

19a. Dental papillae present; oral papillae absent; longest arm spines denticulate in outline, and glassy-translucent in appearance; length of longest arm spines typically > 2 times length of an arm segment (family Ophiotrichidae, genus *Ophiothrix*, Fig. 5) - 20.

19b. Dental papillae absent; oral papillae present, oral papillae may be restricted to distal corners of jaw; arm spines not denticulate in outline and opaque in appearance; length of longest arm spines typically < 2 times length of an arm segment - 29.

from 19a, Fig. 10

20a. Aboral disk with spines several mm in length which usually resemble aboral most arm spines in shape and size, or aboral disk with narrow short spinelets/thorny stumps 1-2 mm in length - 21.

20b. Aboral disk with scattered thorny-topped tubercles, giving disk bumpy appearance - 24.

from 20a, Fig. 10

21a. Aboral disk with spines several mm in length which usually resemble aboral most arm spines in shape and size - 22.

21b. Aboral disk with narrow, short spinelets and/or thorny stumps 1-2 mm in length, much shorter than arm spines - 23.

from 21a

22a. Arm segments cross-lined by thin yellow-white lines usually in light-dark-light pattern on each arm segment; no stripes running length of arms on aboral side; spines on disk similar or just shorter in length to those on arms, length less than radius of disk; proximal parts of radial shields may have spines; commonly found in rubble or sponges - *Ophiothrix oerstedii*.

22b. No cross lines on arm segments; dark stripe bordered by light stripes running length of arms on aboral side, which often continues on disk surface between radial shields; spines on disk long, similar in length to those on arms, almost equal to the radius of the disk, and occurring between radial shields; radial shields very large occupying most of disk surface and bare of spines; commonly found on sponges and soft corals - *Ophiothrix suensonii*.

from 21b, Fig. 10

23a. Aboral disk densely covered with short stumps and spinelets that have bifid or trifid spiked ends best visible in dry specimens, spinelets not similar in shape to arm spines; proximal ends of radial shields covered with short spinelets, distal ends usually without spinelets; commonly found in oyster, rock, or reef rubble - *Ophiothrix angulata*.

23b. Aboral disk sparsely and evenly covered with short spinelets that do not have distinctly bifid or trifid spiked ends, spinelets similar in shape but shorter than arm spines; radial shields with a few spinelets; described from Central American region - *Ophiothrix cimar*.

from 20b

24a. - Arms with longitudinal dark or light stripes running length of arm on aboral side, stripes may only be apparent on distal half of arm - 25.

24b. Arms without longitudinal dark or light stripes running length of arm on aboral side - 27.

from 24a

25a. Radial shields usually bare, occasionally with only 1-2 tubercles on some shields; arms 7-9 times longer than disk diameter; dark stripe bordered by light stripes usually distinctive along entire aboral surface of arms; commensal on sponges - *Ophiothrix lineata*.

25b. Radial shields usually with some tubercles, 2-3 or more per shield; arms 4-6 times longer than disk diameter; dark stripe bordered by light stripes most distinctive on distal half of arms, or just a light stripe - 26.

from 25b

26a. 2-3 tubercles per radial shield; oral most arm spine on distal half of arms without recurved, translucent tip; faint light stripe on aboral side of arms (only known from holotype) - *Ophiothrix platyactis*.

26b. ≥ 5 tubercles per radial shield; oral most arm spine on distal half of arms with recurved, translucent tip; dark stripe bordered by light stripes on aboral side of arms; described from Central American region - *Ophiothrix stri*.

from 24b

27a. Radial shields usually lacking tubercles, occasional 1-2 tubercles on some shields - *Ophiothrix brachyactis*.

27b. Radial shields with some to many, > 3 , tubercles on most shields - 28.

from 27b

28a. Arm spines white; radial shields with < 5 tubercles per shield (only known from holotype) - *Ophiothrix hartfordi*.

28b. Arm spines blue; radial shields usually with > 5 tubercles per shield; commensal living underneath *Echinometra lucunter* the red-rock sea urchin, so far only reported from Columbia - *Ophiothrix synoecina*.

from 19b, Figs. 2, 10

29a. < 4 genital (bursal) slits per interbrachial area, usually two long slits, sometimes hard to see due to inflated nature of interbrachial surface - 30.

29b. 4 short oval genital (bursal) slits per interbrachial area, unmistakable on flat interbrachial surface (family Ophiidermatidae in part, genus *Ophioderma*, Fig. 5) - 31.

from 29a, Fig. 1

30a. Aboral disk covered with granules, also possibly a few small spines (family Ophiidermatidae in part) - *Ophiurochaeta littoralis*.

30b. Aboral disk covered with scales, skin, or scales and scattered spines or papillae, no granules - 44.

from 29b, Fig. 1

31a. - Most aboral arm plates on proximal half of arm divided into multiple pieces - 32.

31b. - Most aboral arm plates on proximal half of arm undivided, a few may be split in half - 34.

from 31a

32a. - Granules on aboral disk spherical-rounded; aboral arm plates usually divided into 3-4 irregular pieces; all radial shields completely exposed; 8-10 arm spines per side arm plate; disk and arm colour various shades of brown, red-brown - *Ophioderma cinereum*.

32b. - Granules on aboral disk distinctly flattened on top, resembling cobblestones; aboral arm plates usually divided into ≥ 4 pieces; some or all radial shields covered with granules; ≤ 8 arm spines per side arm plate - 33.

from 32b

33a. Aboral arm plates divided into 7 geometrically arranged pieces, 1 trapezoidal piece in middle with 3 hexagonal pieces on either side forming symmetric diagonal band around arm; a few radial shields may be partly exposed; colour in life bright orange-red - *Ophioderma squamosissimum*.

33b. Aboral arm plates divided into multiple pieces of different sizes and shapes, and irregularly arranged; radial shields covered with granules; disk colour gray with tiny black dots - *Ophioderma guttatum*.

from 31b, Fig. 10

34a. Some or all radial shields exposed - 35.

34b. All radial shields covered with granules - 39.

From 34a, Fig. 10

35a. Adoral shields covered with granules; some radial shields may be covered with granules; disk colour usually red or red-brown with tiny white dots contrasting with red-brown or green-brown arms - *Ophioderma phoenium*.

35b. Adoral shields exposed; all radial shields exposed - 36.

from 35b

36a. 10-12 arm spines per side arm plate; disk and arm colour mottled purple-red and white - typical specimens of *Ophioderma rubicundum*.

36b. < 10 arm spines per side arm plate - 37.

from 36b

37a. Length of all arm spines less than the length of an arm segment, oral most arm spine longest about 2/3 of an arm segment in length; disk and arm colour mottled purple-red and white - smaller sized specimens of *Ophioderma rubicundum*.

37b. Length of oral most arm spine \geq the length of an arm segment - 38.

from 37b

38a. 7-9 arm spines per side arm plate; oral most arm spine longest, just reaching podial scales of next arm segment; disk colour brown with yellow blotches, arm colour brown - *Ophioderma anitae*.

38b. 6-7 arm spines per side arm plate; oral most arm spine longest, covering podial scales and reaching base of arm spines on next arm segment; colour in life disk pink, arms yellow - *Ophioderma ensiferum*.

from 34b, Fig. 10

Note for couplet 39: certain specimens of *O. phoenium* may key to this spot, see 35a.

39a. Adoral shields covered with granules - 40.

39b. Adoral shields exposed - 41.

from 39a

Note for couplet 40: certain specimens of *O. brevispinum* may key to this spot, it has arm spines all similar in size, with arm length 5-6 times disk diameter, see 43a.

40a. Arm length 4-5 times disk diameter; 8-10 arm spines per side arm plate, oral most arm spine distinctly longest and widest of arm spines; disk and arm colour gray-green, sometimes red blotch on disk - some specimens of *Ophioderma appressum*.

40b. Arm length 3-4 times disk diameter; 8-9 arm spines per side arm plate, all similar in length; disk and arm colour gray-green - *Ophioderma brevicaudum*.

from 39b, Fig. 10

41a. Oral most arm spine distinctly longest and widest of arm spines - 42.

41b. All arm spines similar in length and width - 43.

from 41a

42a. Disk and arm colour mottled purple-red and white - some specimens of *Ophioderma rubicundum*.

42b. Disk and arm colour gray-green, sometimes red blotch on disk - some specimens of *Ophioderma appressum*.

from 41b, Fig. 11

43a. Length of arm spines about half the length of an arm segment; arm width at disk connection not narrowed, width about 1/5 of disk diameter - *Ophioderma brevispinum*.

43b. Length of arm spines about equal to length of an arm segment; arm width at disk connection narrowed, width 1/6-1/7 of disk diameter; South American coast - *Ophioderma januarii*.

from 30b, Fig. 1

44a. Aboral surface of disk with scales of two distinctly different sizes, large scales 2-4 times larger than small scales with small scales partly or completely surrounding large scales, scales may be flat or may be inflated and pebble-like; very narrow triangular shaped straight sided accessory aboral arm plates present on distal corners of aboral arm plates at least on first few arm segments (family Ophiolepididae, genus *Ophiolepis*, Fig. 6) - 45.

44b. Aboral surface of disk with skin or small, flat, overlapping scales of similar size; spines or papillae may be present on disk; accessory aboral arm plates either absent, or very large with broadly rounded edges in some cases taking up almost half of aboral surface of an arm segment - 50.

from 44a

45a. 4-6 arm spines per side arm plate - 46.

45b. 1-3 arm spines per side arm plate - 47.

from 45a

46a. Aboral disk scales very flat and non-overlapping; large scales 4-5 times larger than small scales forming rosette pattern on disk; small scales brick-like and completely encircle large scales; 1 column of large scales between radial shields in both interarm and arm axis areas - *Ophiolepis elegans*.

46b. Aboral disk scales slightly inflated, pebble-like and partly overlapping; large scales 2-3 times larger than small scales; small scales irregular in shape and may not completely encircle large scales; > 1 column of large scales between radial shields in interarm axis area - *Ophiolepis impressa*.

from 45b

47a. 1-2 arm spines per side arm plate - *Ophiolepis paucispina*.

47b. 3 arm spines per side arm plate - 48.

from 47b

48a. Very few small aboral disk scales scattered among larger scales; arms distinctly banded with blotches of white interspersed with blotches of red-brown, similar colour pattern on disk - *Ophiolepis pawsoni*.

48b. Large aboral disk scales almost completely surrounded by smaller disk scales; colour gray-tan without distinct white blotches on arms and disk - 49.

from 48b

49a. Aboral disk scales flat often geometric in shape with distinct sides, rather than irregular in outline; radial shields smooth; distal arm segments longer than wide; usually found deeper than 20 m - *Ophiolepis gemma*.

49b. Aboral disk scales inflated, pebble-like; radial shields tuberculate and pitted; distal arm segments wider than long - *Ophiolepis kieri*.

From 44b, Figs. 1, 2, 11

50a. Large broadly rounded accessory aboral arm plates present on either side of aboral arm plates, accessory plates may occupy almost half of aboral side of an arm segment; aboral disk scales very small and greatly overlapping, no spines or papillae present; oral papillae form continuous series around jaw (family Ophionereididae, genus *Ophionereis*, Fig. 6) - 51.

50b. Accessory aboral arm plates absent; aboral disk with naked skin or overlapping scales, possibly with spines or papillae present; oral papillae are either concentrated at distal corners of jaw, or are on sides of jaw with two quadrate shaped papillae set side by side at apex of jaw with a slight gap between them - 55.

from 50a, Fig. 11

51a. Elongate plates-scales bordering genital (bursal) slits on oral interbrachial area without small papillae - 52.

51b. Elongate plates-scales bordering genital (bursal) slits on oral interbrachial area with small papillae - 53.

from 51a

52a. Aboral disk with net-like dark coloured lines; arm colour banded with 2-3 arm segments of white and 1-2 arm segments of dark, no stripe on arms on aboral side; arm spines very pointed, length of arm spines about twice the length of an arm segment; only reported from Venezuela, usually found deeper than 30 m - *Ophionereis dolabriformis*.

52b. Aboral disk with net-like yellow-gold coloured lines; small scales associated with accessory aboral arm plates; arm colour banded with 3-4 arm segments of white and 1-2 arm segments of dark, red (greenish when preserved) stripe running length of arm on aboral side; arm spines with rounded tips, length of arm spines about equal to the length of an arm segment; commonly found on deep forereef, usually deeper than 20 m - *Ophionereis vittata*.

from 51b

53a. Aboral disk pentagonal in outline, colour of gray-green background spotted with lighter blotches; commonly found in algae - *Ophionereis olivacea*.

53b. Aboral disk circular in outline, colour of white-gray background with net-like dark lines; commonly found in reef rubble - 54.

from 53b

54a. Aboral disk up to 15 mm diameter; arm colour banded with 3-5 arm segments of light white-tan and 1-2 arm segments of dark brownish-red - *Ophionereis reticulata*.

54a. Aboral disk up to 6 mm diameter; arm colour banded with 3-4 arm segments of dark greenish-brown and 1-2 arm segments of light white-tan - *Ophionereis squamulosa*.

from 50b, Fig. 11

Note for couplet 55: families Ophiactidae and Amphiuridae contain numerous small species (disk diameters often ≤ 5 mm) that are easy to confuse with one another. Many ophiactids undergo fissiparous reproduction and many amphiurids readily autotomize the disk, so the characteristics of the disk and arms may not always be consistent.

55a. Oral papillae concentrated at distal corners of jaw, missing from near proximal apex; 2-6 oral papillae per jaw (1-3 per side) (family Ophiactidae, Fig. 7) - 56.

55b. Oral papillae on sides of jaw and 2 quadrate shaped papillae set side by side at proximal apex of jaw with a slight gap between them; 6-10 oral papillae per jaw (3-5 per side) (family Amphiuridae, commonly found in soft bottom habitats of sand, mud or sea grass) - 63.

from 55a

56a. 5 arms (fissiparous 6-armed species occasionally grow back with only 5 arms) - 57.

56b. 6 arms - 58.

from 56a

57a. Oral interbrachial area with naked skin; aboral disk with scales, lacking spines; 3 smooth, pointed arm spines per side arm plate; 2 oral papillae per jaw (1 at each distal corner); commonly found in sand - *Hemipholis elongata*.

57b. Oral interbrachial area with some scales; aboral disk with scales and usually a few, scattered short spines; 5-6 arm spines per side arm plate; 4-6 oral papillae per jaw (2-3 at each distal corner); disk colour red-brown; commonly found with sponges - *Ophiactis quinquerradia*.

from 56b

58a. 5-6 arm spines per side arm plate; 4-6 oral papillae per jaw (2-3 at each distal corner), occasionally fewer; radial shields with white spot on distal end; disk colour green-tan - *Ophiactis savignyi*.

58b. 4 arm spines per side arm plate; 2-4 oral papillae per jaw (1-2 at each distal corner) - 59.

from 58b, Figs. 3, 11

59a. Aboral arm plates fan shaped, not broadly in contact with one another; disk colour red-brown or gray-brown; arm spines with dark spot; commonly found in algae - *Ophiactis algicola*.

59b. Aboral arm plates oval to trapezoidal in shape, broadly in contact with one another - 60.

from 59b, Fig. 3

60a. Podia coloured bright red (lost on preservation); oral arm plates octagonal shaped - *Ophiactis rubropoda* (see notes on *Ophiactis simplex*).

60b. Podia not coloured bright red; oral arm plates not octagonal shaped - 61.

from 60b, Figs. 2, 3

61a. Aboral disk without spines; oral arm plates quadrate shaped (only known from holotype) - *Ophiactis notabilis*.

61b. Aboral disk with spines; oral arm plates pentagonal or hexagonal shaped - 62.

from 61b

62a. Aboral disk with scattered spines, colour blue-green; radial shields in contact along distal half of total length - *Ophiactis muelleri*.

62b. Aboral disk with spines only on periphery or oral side of disk, colour red-brown or green-brown; radial shields in contact only at distal ends; usually found deeper than 20 m - *Ophiactis lymani*.

from 55b, Fig. 1

63a. Aboral disk with naked skin, at least in center, a few scales may be present on margin of disk; radial shields very narrow rectangular shaped - 64.

63b. Aboral disk all scaled, possibly with spines or papillae; radial shields usually oval shaped - 65.

from 63a

64a. A few aboral disk scales at the proximal end of radial shields; a line of scales along disk margin originating at the distal end of the radial shields; 8-10 oral papillae per jaw (4-5 per side) - *Ophionephtys limicola*.

64b. Aboral disk without scales; 6 oral papillae per jaw (3 per side) - *Amphiura (Ophionema) intricata*.

from 63b

65a. Aboral disk with spines or papillae, which may be restricted to margin of disk - 66.

65b. Aboral disk without spines or papillae; disk scales near margin may be raised forming a line-like border around disk - 75.

from 65a, Fig. 11

66a. Aboral disk with spines or short papillae more or less evenly scattered across all disk surface, not concentrated around disk margin - 67.

66b. Aboral disk with spines or short papillae only on margin of disk forming a "fence" encircling disk (genus *Ophiophragmus*; small individuals may have a few papillae in center of disk, but the "fence" papillae are still distinct, Fig. 8) - 69.

from 66a, Fig. 11

67a. 6 oral papillae (3 per side), all similar in size; radial shields without papillae; - *Ophiocnida scabriuscula*.

67b. 6 oral papillae (3 per side), with the distal most oral papillae rectangular shaped and distinctly 2-3 times larger in size than the proximal oral papillae; proximal ends of radial shields often covered by papillae, scales not distinct; (genus *Ophiostigma*, Fig. 7) - 68.

from 67b

68a. 5 arms; proximal aboral arm plates in contact with one another; proximal oral arm plates as wide or just wider than long and in contact with one another; all pairs of adoral shields contact one another at both ends within and between pairs - *Ophiostigma isocanthum*.

68b. 6 arms (fissiparous species occasionally grows back only 5 arms); proximal oral arm plates longer than wide and not quite in contact with one another due to large side arm plates; adoral shields in contact only at proximal medial ends within pairs - *Ophiostigma siva*.

from 66b, Fig. 11

69a. Oral interbrachial area with spines or short papillae, often in triangular shaped patches, similar to spines or short papillae on disk margin; arm colour mostly dark with occasional light bands, or dark and light bands each 2-3 arm segments wide - 70.

69b. Oral interbrachial area without spines or short papillae; arm colour usually light and dark banded, often with stripe running along length of arm on aboral side - 71.

from 69a, Fig. 11

70a. 2 podial scales per podial pore set at right angles and separated from one another by a distinct gap; arm colour mostly dark with occasional light bands; aboral arm plates not split in half; only reported from estuaries and bays in Florida - *Ophiophragmus filigraneus*.

70b. 2 podial scales per podial pore in close contact with one another; arm colour with dark and light bands each 2-3 arm segments wide; some aboral arm plates split in half - *Ophiophragmus cubanus*.

from 69b, Fig. 11

71a. Middle arm spine on arm segments extending across oral surface of disk with 2-5 translucent conical spikes at tip of spine - *Ophiophragmus riisei*.

71b. Middle arm spine on arm segments extending across oral surface of disk without 2-5 translucent conical spikes at tip of spine, although tip may have a serrated appearance - 72.

from 71b, Fig. 11

72a. 2 podial scales per podial pore set at right angles and separated from one another by a distinct gap; usually without a stripe running along the length of the arm on the aboral side - 73.

72b. 2 podial scales per podial pore in close contact with one another; usually with a stripe, light or dark, running along the length of the arm on the aboral side, stripe may be intermittent; arms may also be cross banded - 74.

from 72a

73a. Fence papillae long, similar in shape and length to arm spines; every oral arm plate darkly coloured; only reported from the northern Gulf of Mexico - *Ophiophragmus moorei*.

73b. Fence papillae shorter and possibly blunt compared to arm spines; oral arm plates darkly coloured only on darkly banded arm segments, dark bands 1-2 arm segments wide, light bands 3-4 arm segments wide - *Ophiophragmus wurdemanii*.

from 72b, Fig. 11

74a. Middle arm spine straight, not curved progressing towards tip; 6-12 fence papillae between arms on disk margin usually spaced apart from one another; distal sides of oral shields convex, proximal sides of oral shields concave; arm stripe green or red in life, green or brown band 1 arm segment wide every 3-4 arm segments - *Ophiophragmus pulcher*.

74b. Middle arm spine curved progressing towards tip; > 15 fence papillae between arms on disk margin usually set close to one another; distal sides of oral shields slightly convex to straight, proximal sides of oral shields slightly convex to straight; arm stripe dark or light in life, arms irregularly banded - *Ophiophragmus septus*.

from 65b, Fig. 11

Note for couplet 75: the distal most oral papillae often project from the adoral shields rather than the jaw edge proper, may be spine-like, and may be separated from other oral papillae by a gap.

75a. 8-10 oral papillae per jaw (4-5 per side) (genus *Amphioplus*, Fig. 8) - 76.

75b. 6 oral papillae per jaw (3 per side) (Fig. 9) - 78.

from 75a, Figs. 2, 10

76a. 1 podial scale per podial pore (a few arm segments near disk may have 2 podial scales); scales on aboral disk with inflated distal margins giving disk a tuberculate appearance - *Amphioplus thrombodes*.

76b. 2 podial scales per podial pore; scales on aboral disk surface without inflated distal margins - 77.

from 76b, Figs. 2, 3

77a. Oral interbrachial area with naked skin, without scales; 3 arm spines acutely pointed - *Amphioplus coniertodes*.

77b. Oral interbrachial area with scales; 3 arm spines flattened with bluntly rounded ends - *Amphioplus sepultus*.

from 75b, Fig. 11

78a. Gap between oral papillae at apex of jaw and other oral papillae on side of jaw; middle oral papillae and distal most oral papillae not in same plane on jaw edge, middle oral papillae set deeper on jaw, distal most oral papillae project from adoral shields (genus *Amphiura*, Fig. 9) - 79.

78b. No gap between oral papillae at apex of jaw and other oral papillae on side of jaw; middle oral papillae and distal most oral papillae in same plane on edge of jaw - 81.

from 78a, Figs. 2, 10

79a. 1 podial scale per podial pore on most arm segments - 80.

79b. 2 podial scales per podial pore on most arm segments - *Amphiura palmeri*.

from 79a, Fig. 3

80a. 5-8 arm spines per side arm plate, middle arm spines typically blunt ended with small teeth projecting laterally at very end; aboral arm plates egg shaped; oral arm plates quadrate shaped, just longer than wide - *Amphiura fibulata*.

80b. 3-5 arm spines per side arm plate, middle arm spines typically rounded without small teeth projecting laterally at very end; aboral arm plates trapezoid shaped with broadly convex distal margin; oral arm plates rectangular shaped, longer than wide - *Amphiura stimpsonii*.

from 78b, Figs. 2, 10

Note for couplet 81: the genera *Amphipholis* and *Amphiodia* are practically indistinguishable from one another. The traditional division concerns the size and opercular nature of the distal most oral papillae, however, an almost continuous range in variation in size within and between species exists in that character. I have focused on other characters to discern among species for both genera (Fig. 9).

81a. 1 podial scale per podial pore on most arm segments - *Amphiodia pulchella*.

81b. 2 podial scales per podial pore on most arm segments - 82.

from 81b, Figs. 1-3

82a. Arm length 3-4 times disk diameter; aboral and oral arm plates separated from one another by large side arm plates; aboral arm plates half moon shaped with straight edge distal - *Amphipholis squamata*.

82b. Arm length 5-20 times disk diameter; aboral arm plates not separated from one another by large side arm plates; aboral arm plates widely oval in shape - 83.

from 82b, Fig. 11

83a. Radial shields narrow rectangular shaped with straight lateral sides, 3-5 times longer than wide, about half the radius of the disk, often with a small non-overlapping circular scale at distal end of each radial shield - 84.

83b. Radial shields triangular or oval shaped with convex lateral sides, 1-2 times longer than wide, less than half the radius of the disk - 86.

from 83a, Fig. 11

84a. Proximal-medial ends of adoral shields in contact proximal to oral shield; aboral arm plates twice as wide as long with lateral sides broadly rounded; only reported from bays in Columbia - *Amphiodia guillermosoberoni*.

84b. Proximal-medial ends of adoral shields just separated from one another by proximal end of oral shield at least on some jaws; aboral arm plates 3-4 times as wide as long with lateral sides coming to rounded point - 85.

from 84b, Figs. 2, 3

85a. Middle arm spine flattened and blunt ended with small teeth projecting laterally at end; oral shields diamond shaped with all sides nearly equal in length and slightly convex - *Amphipholis januarii*.

85b. Middle arm spine similar to other arm spines, conical-pointed on end; oral shields fan shaped, with distal end of oral shields convex-circular in shape, and proximal end with longer angled sides - *Amphipholis gracillima*.

from 83b, Fig. 11

Note for couplet 86: certain specimens of *Amphipholis januarii* may key to this spot, see 85a for arm spines, other species at this point in the key have blunt ended arm spines without lateral teeth.

86a. Proximal-medial ends of adoral shields in contact proximal to oral shield - 87.

86b. Proximal-medial ends of adoral shields not in contact, just separated by proximal end of oral shield - *Amphiodia planispina*.

from 86a

87a. Disk scales relatively large, 6-10 scales from center of disk to disk margin; oral arm plates quadrate shaped and broadly in contact with one another - *Amphiodia trychna*.

87b. Disk scales relatively small, > 15 scales from center of disk to disk margin; oral arm plates pentagonal shaped with point of pentagon proximal - *Amphiodia atra*.

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APPENDIX 1: Glossary of Terms

Direction

Aboral - side of animal not containing the mouth, referred to as dorsal in some publications.

Oral - side of animal containing the mouth, referred to as ventral in some publications.

Distal - direction or side moving away from the center of the animal.

Proximal - direction or side moving toward the center of the animal.

Medial - direction toward midline of arm or structure.

Lateral - direction toward outer edges of arm or structure.

Aboral Side Disk

Radial Shields - two enlarged plates (10 total) on the disk near each of the arm connections.

Oral Side Disk

Interbrachial - area of the disk between the arms and distal to the jaws.

Jaws - five triangular areas making up the mouth frame. The jaw apex points towards the center of the mouth.

Dental Papillae - short, finger-shaped projections at the jaw apex, just deep to the oral surface of the jaw.

Teeth - rectangular plates that line the jaw apex, stacked on top of one another deep into the mouth. The teeth will be deep to dental papillae if dental papillae are present.

Oral Papillae - various shaped plates that line the oral most edges of each jaw projecting into the mouth slits. The two block-like oral papillae at the jaw apex in amphiurids are often labeled infradental papillae, a term I have found more confusing than informative for most people due to similar terms oral papillae, dental papillae and teeth and it is not used in this key.

Oral Shield - the plate (5 total) at the juncture of the proximal end of the interbrachial area and the distal end of each jaw.

Madreporite - opening for the water vascular system. In basket stars the madreporite appears as a small oval on the interbrachial area. In other brittle stars it occurs on one of the oral shields.

Adoral Shields - two small plates (10 total) adjoining each of the oral shields situated either to the lateral or proximal side of the oral shield.

Genital (bursal) slits - openings on the interbrachial area next to the arms where the arms extend across the oral surface of the disk.

Arms

Aboral Arm Plate - the plate of an arm segment covering the aboral surface.

Accessory Aboral Arm Plate - small plates at either distal angle of aboral arm plate.

Side Arm Plate - the plate on either side of an arm segment to which the arm spines attach.

Oral Arm plate - the plate of an arm segment covering the oral surface.

Podia (tentacles) - tube feet at the end of the water vascular system used in gathering food and in respiration. Podia project through small holes on either side of the oral arm plates.

Podial Scale (tentacle scale) - the small plate(s) on the oral arm plate that cover the podial pores (holes) for the podia.

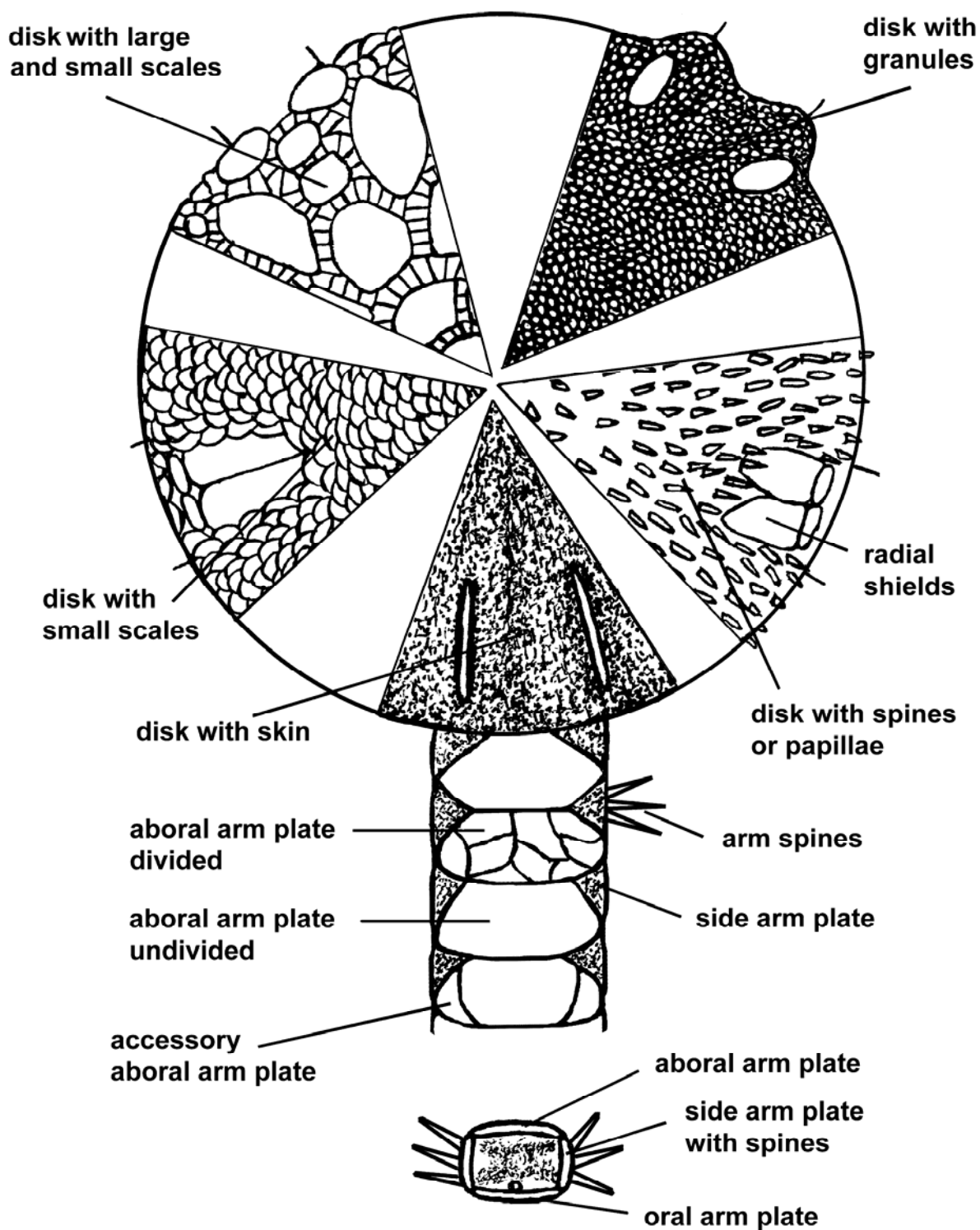


Fig. 1. Aboral side composite disk and arm illustrating main anatomical features of ophiuroids.

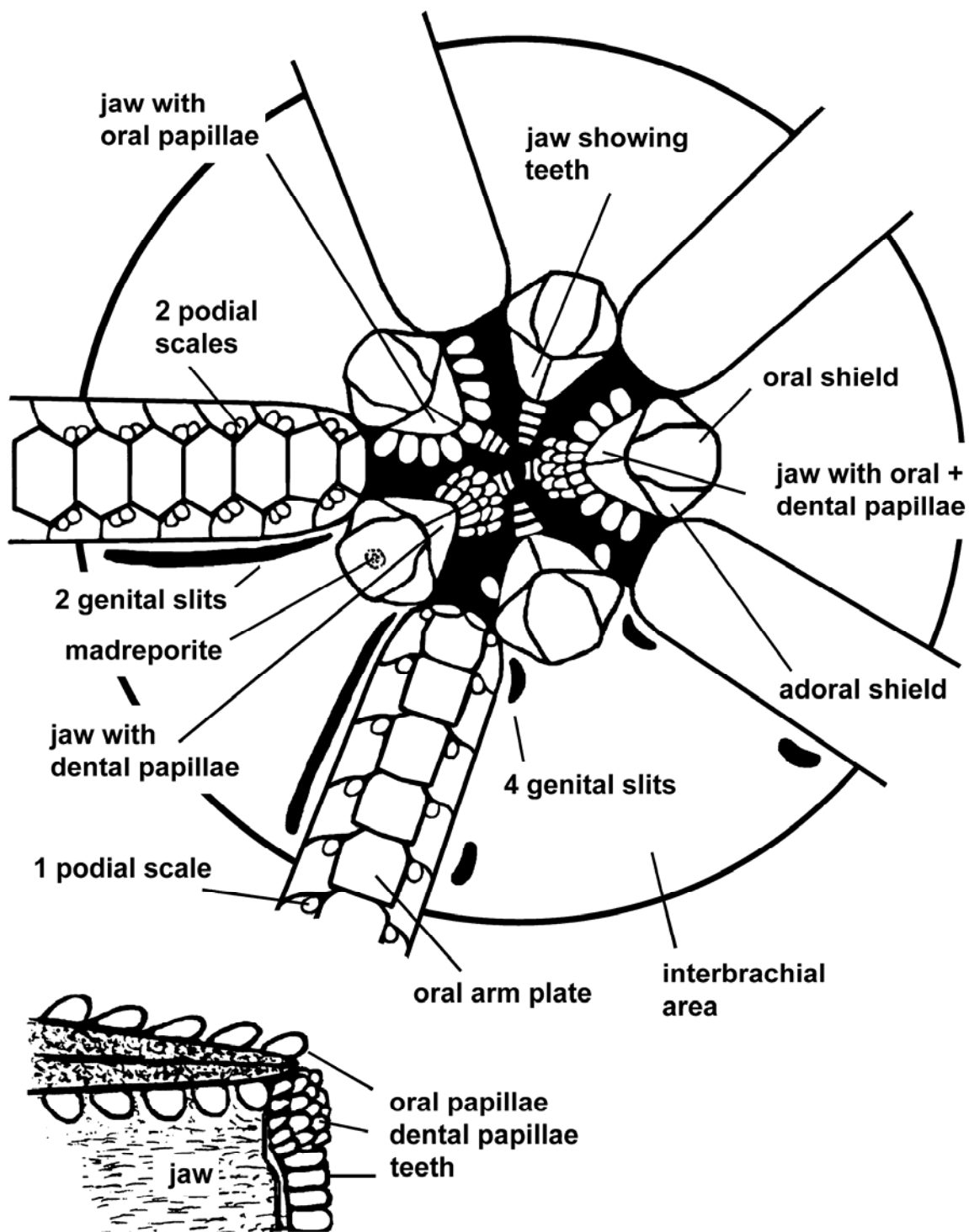
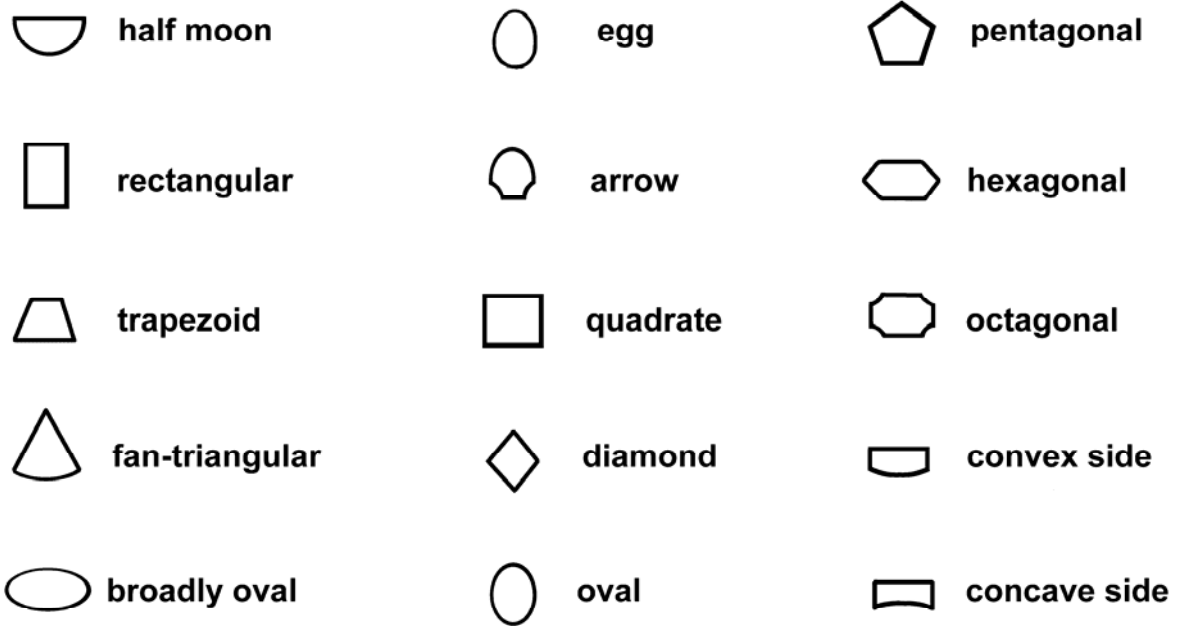


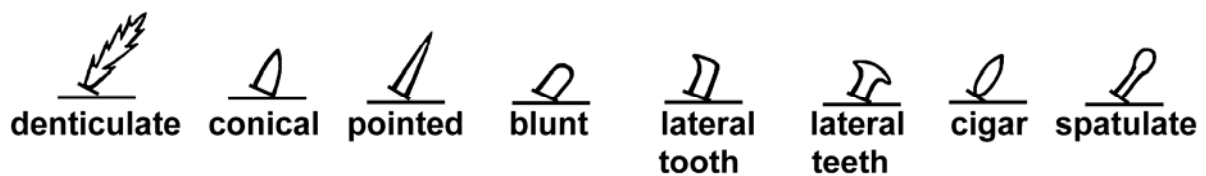
Fig. 2. Oral side composite disk and arm illustrating main anatomical features of ophiuroids.



Arm Plate Shapes



Disk Covering



Arm Spine Shape

Fig. 3. Illustration of terms describing shapes of plates, disk covering and spines.

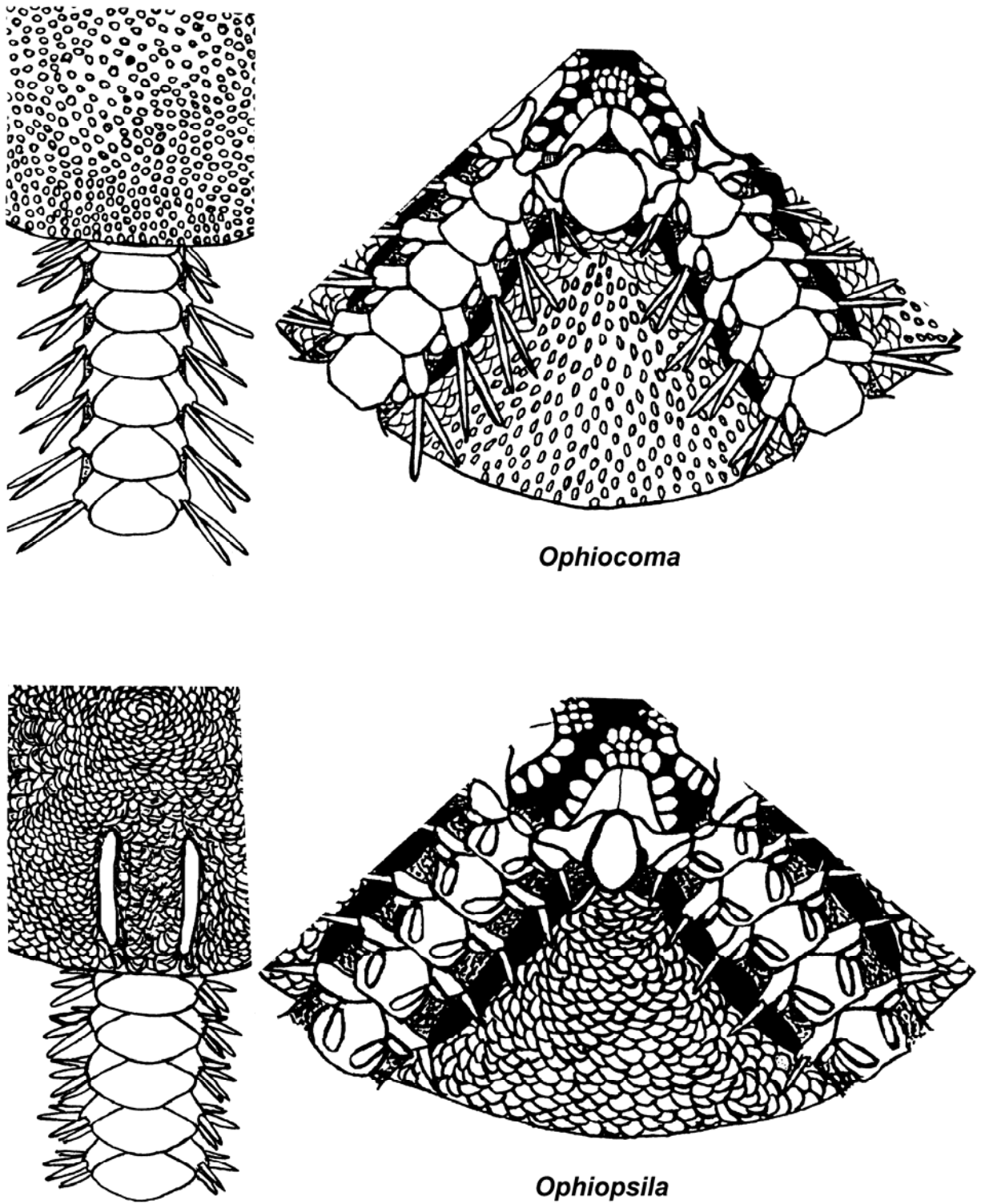


Fig. 4. Illustration of common genera *Ophiocoma* and *Ophiopsila*.

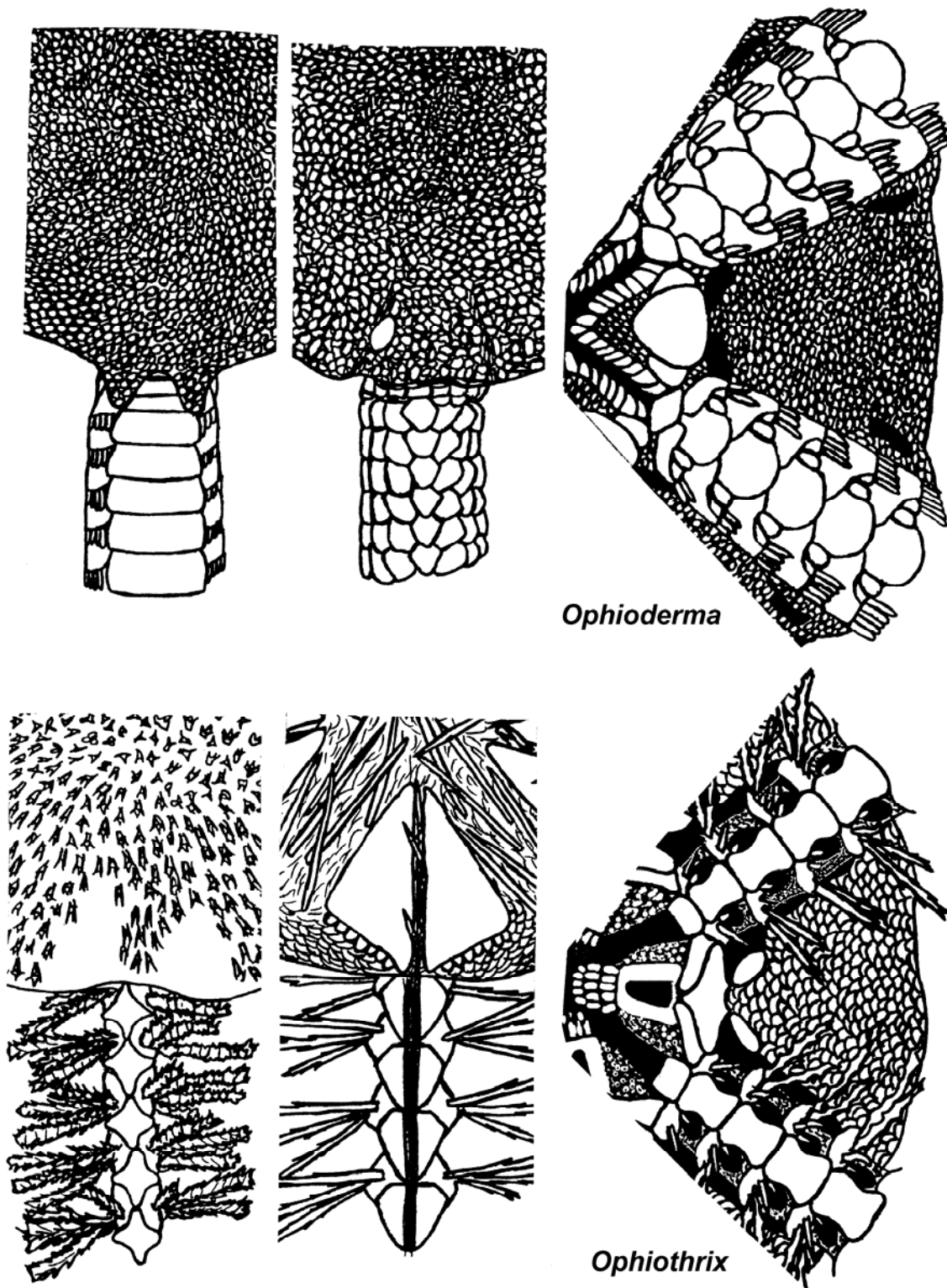


Fig. 5. Illustration of common genera *Ophioderma* and *Ophiothrix*.

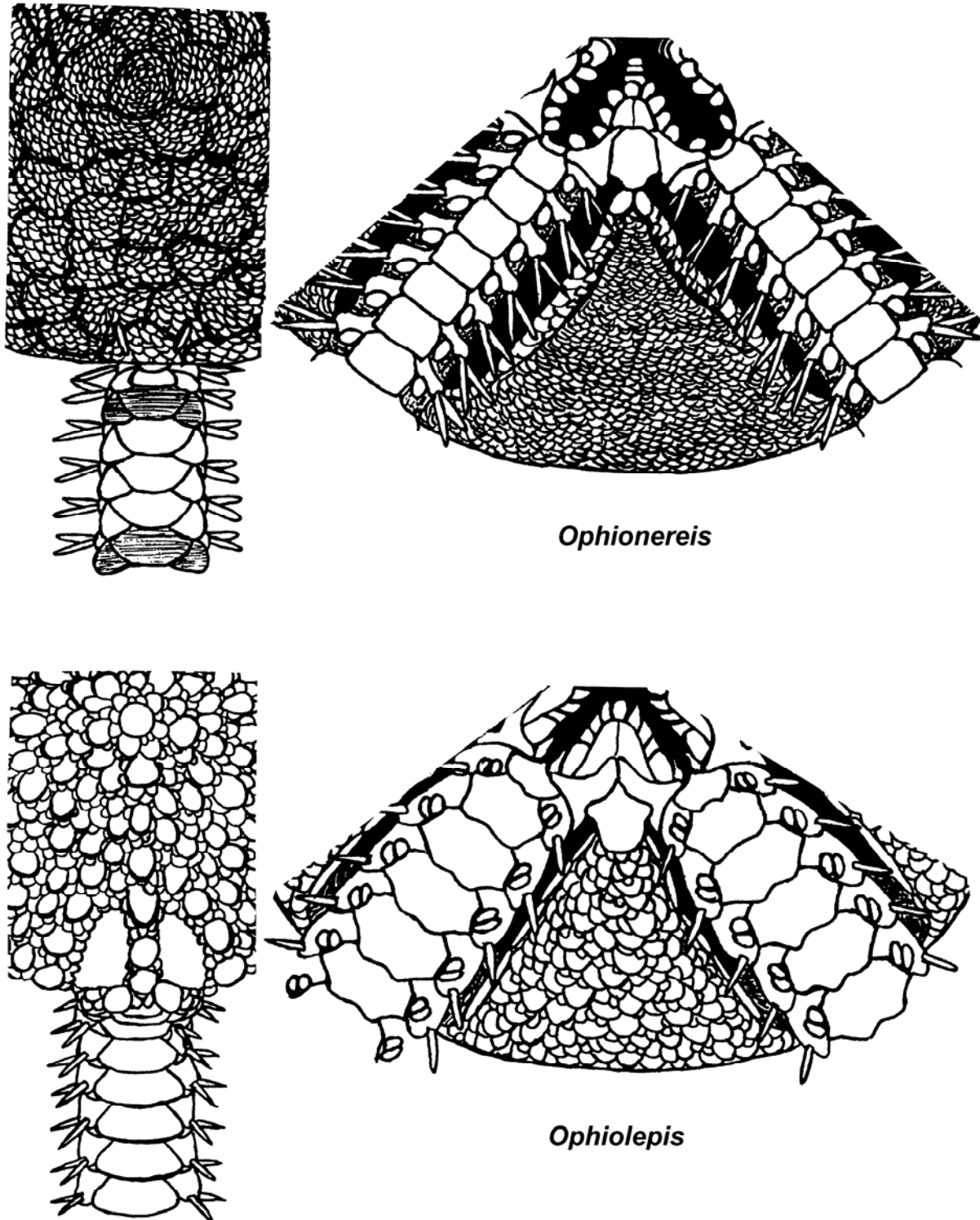


Fig. 6. Illustration of common genera *Ophionereis* and *Ophiolepis*.

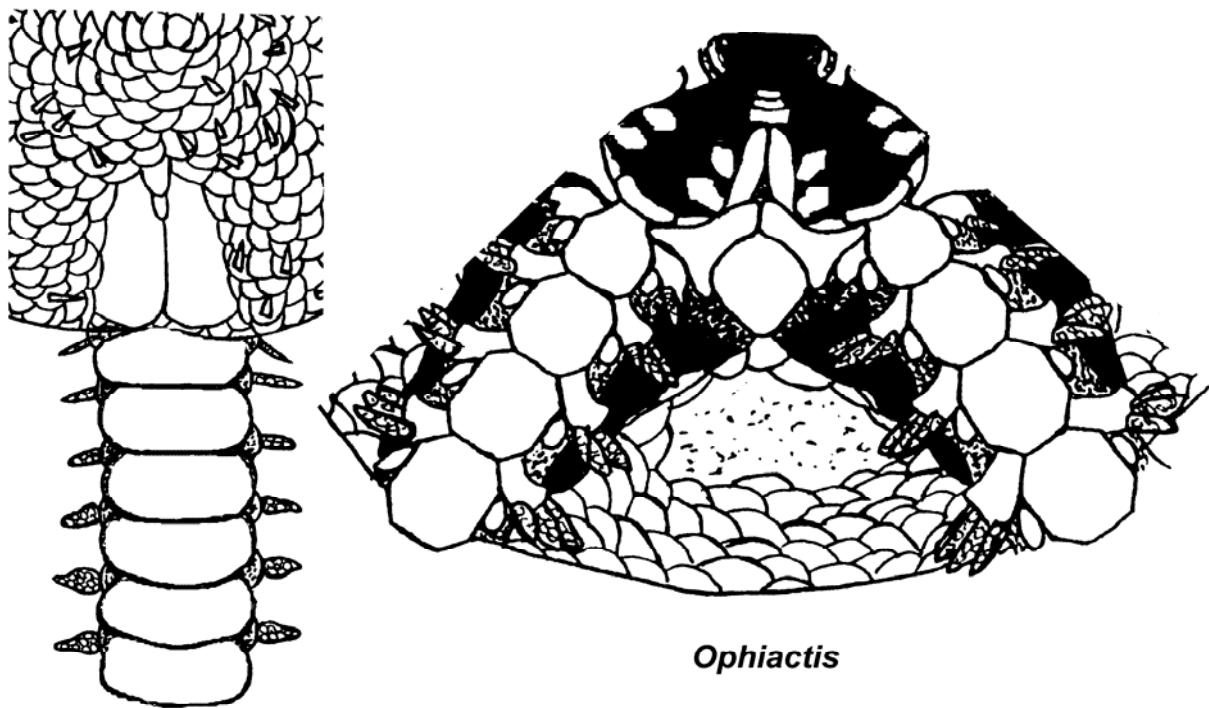
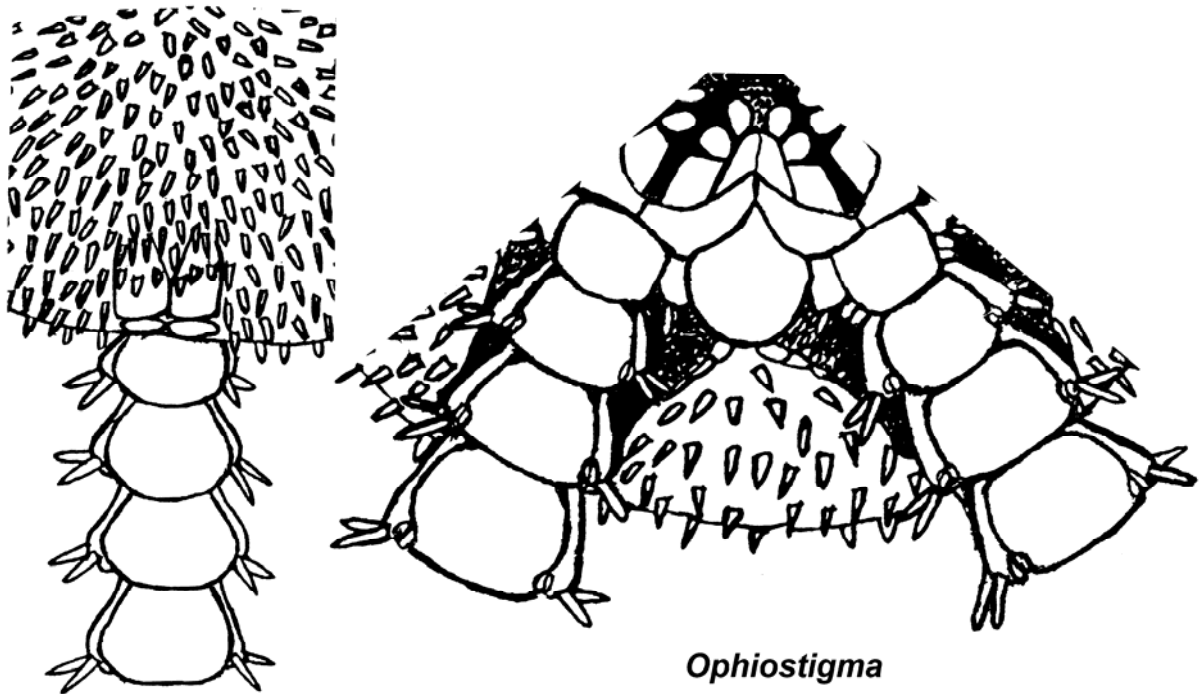


Fig. 7. Illustration of common genera *Ophiostigma* and *Ophiactis*.

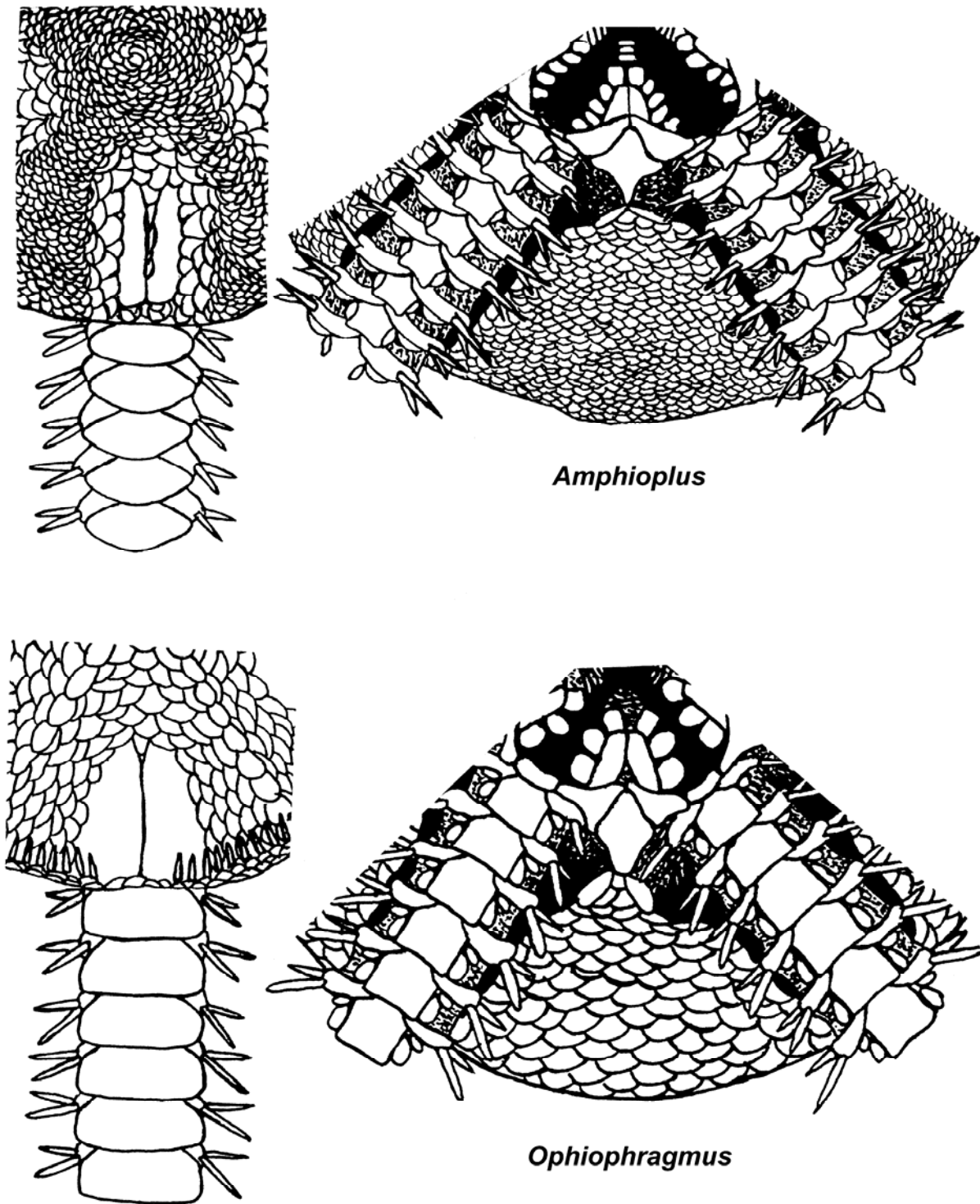


Fig. 8. Illustration of common genera *Amphioplus* and *Ophiophragmus*.

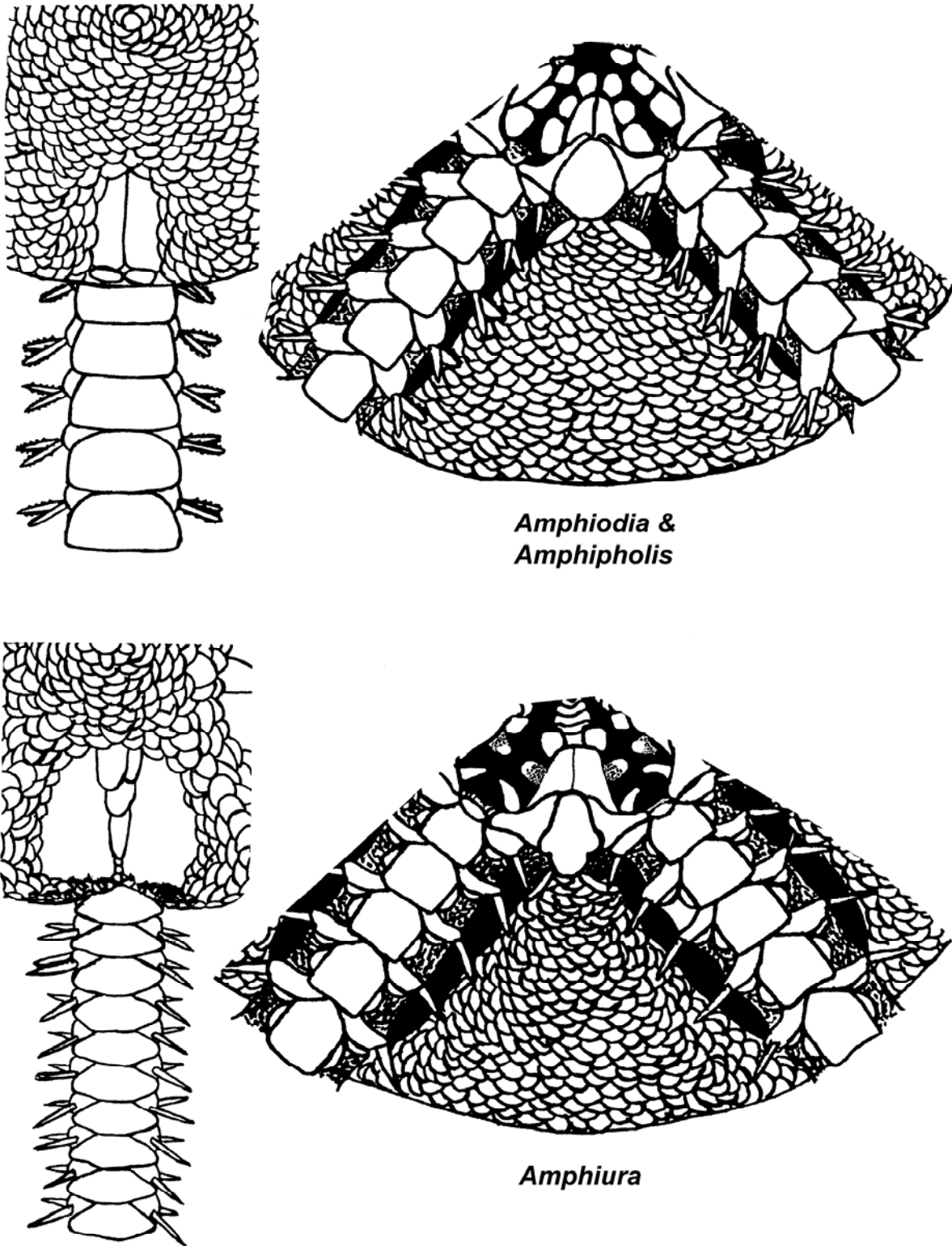


Fig. 9. Illustration of common genera *Amphiodia & Amphipholis* and *Amphiura*.

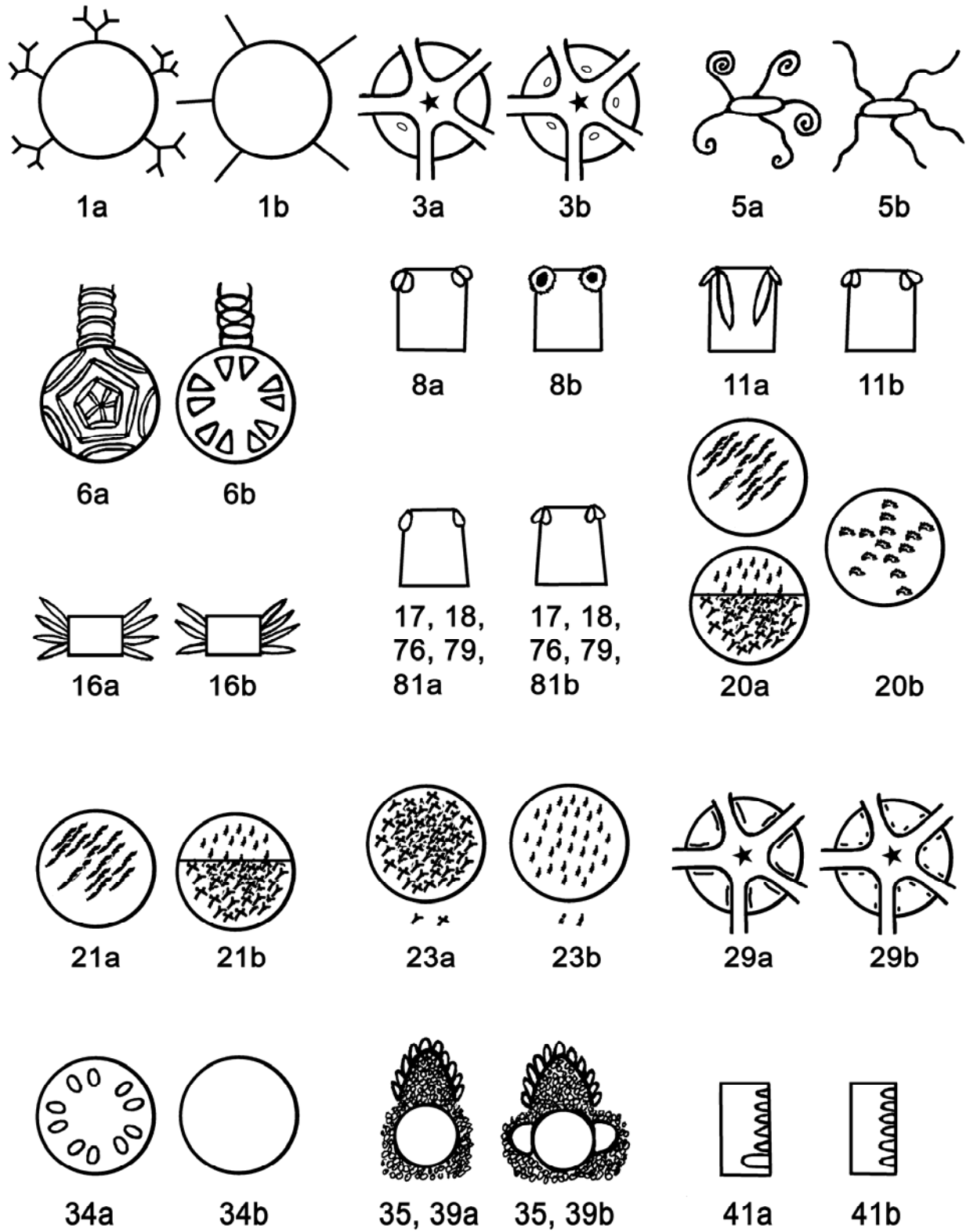


Fig. 10. Stick-figure diagrams illustrating couplets in the key. Numbers refer to couplets.

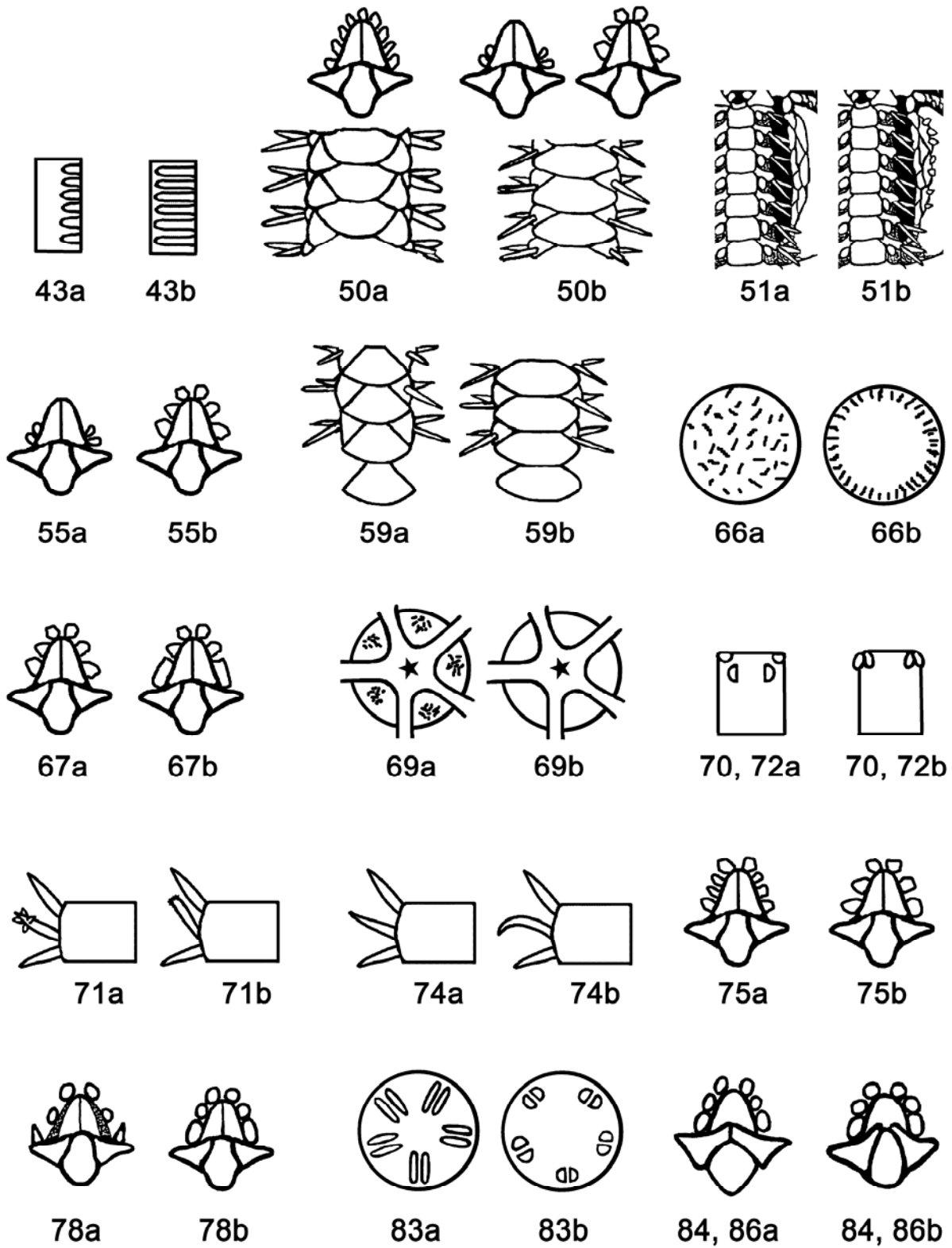


Fig. 11. Stick-figure diagrams illustrating couplets in the key. Numbers refer to couplets.