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A REVIEW OF THE GENUS *OPHIODERMA* M. & T.

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The numerous variations in color of the littoral species of *Ophioderma* known from the Pacific coast of tropical America have presented a problem to the taxonomists for many years, chiefly because so few individuals of each species were known. During the years 1933 to 1954 the Velero Expeditions have collected a large number of specimens of *Ophioderma* from the western coasts of tropical America and the offlying Pacific islands. In addition a number of Atlantic specimens were collected in 1939 from the coasts of Panama, Colombia, Venezuela, and various islands, especially Tobago. This vast amount of material has given us more knowledge of some of the species, which in many cases had been established on a single specimen.

It has been the writer's good fortune as a member of the Velero Expeditions to help collect this material and later study it in the Allan Hancock Foundation. In addition he has had the opportunity to study the large collections of *Ophioderma* in the Museum of Comparative Zoology and the United States National Museum. The five species he has not been able to examine are indicated in this paper by an asterisk.

The genus as accepted today includes 21 species. Three have doubtful localities, while two others are reported from the eastern Atlantic. The remaining 16 belong only to American waters. One is known from both the Atlantic and Pacific, while 11 are reported from the western Atlantic and 4 from the Pacific. The majority are shallow water forms,

with only 3, one Atlantic, one Pacific, and one in both Pacific and Atlantic, being reported from deeper waters.

To help future workers on this group, a key is given to all the accepted species, with the literature and distribution for each. Only the Pacific species are discussed in greater detail.

Genus *OPHIODERMA* M. & T.

Ophioderma Müller und Troschel, 1842, Syst. Ast., p. 83, 86.

Ophiocryptus (partim) H. L. Clark, 1915, Jour. Entom. Zool., vol. 7, no. 1, p. 64.

Diagnosis: Differs from the other genera of the family Ophiodermatidae in having four interradial genital slits confined to the underside of the disk, arms twice the length of the disk diameter, and flat disk plates.

Type species: Asterias longicauda Retzius 1805.

Remarks: There are two other genera in the family Ophiodermatidae which have four genital slits, *Ophioncus* Ives and *Ophiocryptus* H. L. Clark. The former, however, has arms barely the length of the disk diameter, while the latter has large convex disk scales. Both are monotypic and restricted to California waters, and range northward beyond the limit of *Ophioderma.* The three species of *Ophiocryptus* described by H. L. Clark and Nielsen are now considered juvenile stages of *Ophioderma.*

KEY TO THE SPECIES OF OPHIODERMA

1. Upper arm plates divided into numerous smaller plates . . . 2
1. Upper arm plates not divided into numerous smaller plates . . 8
2. Radial shields completely covered 3
2. Radial shields normally exposed, sometimes partly covered in *longicaudum* and *teres* 4
3. Distal margin of under arm plate bi-lobed, heart-shaped. Locality doubtful: East Indies . . . . . 1. *propinquum** Koehler
3. Distal margin of under arm plate convex. West Indies . . . 2. *guttatum* Lütken

4. Arm-spines 7 or less 5
4. Arm-spines 8 or more 6
5. Arm length 4 to 5 times disk diameter. Disk grains excessively large, flat, tile-like; no exposed scales on disk. West Indies . . 3. *squamosissimum* Lütken
5. Arm length 3 times disk diameter. Granules small, round; a few disk scales may be exposed; a few upper arm plates may be fused into one piece. Locality doubtful; South Africa . . . . . 4. *wahlbergii** Müller & Troschel
6. Arms short, about 2½ times disk diameter, arms never banded. Panamic . . . . . 5. *teres* (Lyman)
6. Arm length 3½ times disk diameter, or more 7
7. Arm length 3½ times disk diameter, arms banded. West Indian 6. *cinereum* Müller & Troschel
7. Arm length 4½ times disk diameter, arms not banded. East Atlantic . . . . . 7. *longicaudum* (Retzius)
8. Radial shields normally exposed; sometimes partly covered in *phoenium* and *panamense* 9
8. Radial shields covered by disk granulations 12
9. Arm-spines 9, rarely 10 10
9. Arm-spines 10 to 12 11
10. Upper arm plates narrow, arms 4 to 5 times disk diameter, oral shields large, sub-cordate. Havana. 110 to 200 fathoms . . . 8. *pallidum** (Verrill)
10. Upper arm plates broader than long, arm length 3 to 4 times disk diameter. Atlantic . . . . . 9. *phoenium* H. L. Clark
11. Adoral shields concealed; 10 to 12 arm-spines, arms banded. Panamic . . . . . 10. *panamense* Lütken
11. Adoral shields exposed, 10 arm-spines. Atlantic . . . . . 11. *rubicundum* Lütken
12. Adoral shields exposed 13
12. Adoral shields not exposed 19
13. Five arm-spines, rarely 6. Panamic . . . . . 12. *pentacanthum* H. L. Clark
13. Seven arm-spines or more 14
14. Lowermost arm-spine largest 15
14. Arm-spines of equal size 16

15. Arm length 6 times disk diameter. West Indies and Panamic. 73 to 300 fathoms . . . . . 13. *elaps* Lütken

15. Arm length 3 times disk diameter. S.W. Africa . . . . . 14. *leonis** Döderlein

16. Arms broad, not finely tapering at the tips 17

16. Arms slender, finely tapering at tips 18

17. Arm-spines 7 to 9, long, delicate, not flattened, slightly longer than arm segment. Panamic . . . . . 15. *variegatum* Lütken

17. Arm-spines 8 to 9, subequal, pointed, slightly more than one-half the length of arm segment. Atlantic . . . . . 16. *brevispinum* (Say)

18. Arm-spines 8 to 9, well spaced, not flattened, almost the length of arm segment. Arm length 5 to 6 times disk diameter. Atlantic 17. *januarii* Lütken

18. Arm-spines 9 to 10, broad, flat, closely compacted, about ⅔ the length of arm segment; arm length less than 5 times disk diameter. Atlantic . . . . . 18. *holmesii* (Lyman)

19. Arm-spines equal, arms short, length 3 to 4 times disk diameter. Atlantic . . . . . 19. *brevicaudum* Lütken

19. Lowest arm-spine largest, arm length 4 times disk diameter . . 20

20. Arm-spines 8, short, compact, half the length of arm segment, large granules on adoral plate. Locality doubtful. Pacific . . . 20. *tonganum** Lütken

20. Arm-spines 9 to 10, flat, less than length of arm segment, small granules on adoral plates. Atlantic . . . . . 21. *appressum* (Say)

1. *Ophioderma propinquum**

Ophioderma propinqua Koehler, 1895, Mém. Soc. Zool. France, vol. 8, p. 404, pl. 9, fig. 5.

Ophioderma propinquum H. L. Clark, 1923, Annals South African Mus., vol. 13, p. 352.

Java, East Indies, Indian Ocean.

This species seems to be valid but it is highly doubtful if it came from the Indian Ocean as the genus has not been reported from that area since.

It is being retained in the key in the hope that more material may be collected in the future.

2. *Ophioderma guttatum*

Ophioderma guttata Lütken, 1859, Norske Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 197, pl. 1, figs. 8a-8b.
Littoral. Jamaica and Tobago Islands. Rare.

3. *Ophioderma squamosissimum*

Ophioderma squamosissima Lütken, 1856, Vidensk. Medd. Dansk Naturhist. Foren., p. 8; 1859, Norske Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 194, pl. 1, figs. 7a-7b.

Ophioderma squamosissmum H. L. Clark, 1933, Sci. Survey of Porto Rico and Virgin Islands, vol. 16, pt. 1, p. 72.
Littoral. Buccoo Reef, Tobago Island; West Indies.
Exceedingly rare.

4. *Ophioderma wahlbergii**

Ophioderma wahlbergii Müller und Troschel, 1842, Syst. Ast., p. 87; H. L. Clark, 1923, Annals South African Mus., vol. 13, p. 353.
Locality doubtful. Port Natal, South Africa.

The species has been taken only once and both H. L. Clark (1923, p. 353) and Th. Mortensen (1933, p. 382) share the belief that the locality given is problematic. It is included in the key in the hope that some future worker will be able to tie it in with material from a reliable locality.

5. *Ophioderma teres*

Ophiura teres Lyman, 1860, Proc. Boston Soc. Nat. Hist., vol. 7, p. 198; 1865, Mem. Mus. Compar. Zool., vol. 1, no. 1, p. 37, fig. 1.

Ophioderma teres Meissner, 1901, Bronn's Thier-reich, vol. 2, abt. 3, buch 3, p. 915.

Ophioderma teres var. *unicolor* H. L. Clark, 1940, Zoologica [N. Y.], vol. 25, pt. 3, p. 342.

Littoral to 10 fathoms. Reef, ten miles west of Point Malarrimo, Baja California, Mexico, south to La Plata Island, Ecuador;

Galapagos Islands, and the Gulf of California. Common. 77 specimens in Hancock Collection.

As early as 1889 Ives noticed the variation in color and characteristics of *O. teres* and *O. panamense*. Nielsen (1932, pp. 328-330) and Clark (1940, p. 342) have also discussed the relative merits of the distinguishing characteristics of *O. teres*.

In the Hancock Collection there are 77 specimens collected from the west coast of Baja California, Mexico, the Gulf of California south to Ecuador, and the Galapagos Islands. Lyman's description was of an adult from Panama with a disk diameter of 32 mm and an arm length of 133 mm, and listed four outstanding characters: broken upper arm plates, concealed radial shields, proportionately shorter arms, and purple-brown color without mention of banding. Nielsen (1932, p. 333) added: "A more reliable character are [*sic*] the roundish arms of *O. teres*, those of *O. panamense* being more flattened." Only 15 of our largest specimens agree with the above five characteristics and thus could be classed as typical *O. teres*.

The largest specimens were taken at the extreme northern range, from a reef located 10 miles west of Malarrimo Point, west coast of Baja California, Mexico. The series ranges in size from 25 to 42.5 mm in disk diameter and 91 to 162 mm in arm length. The radial shields in this lot are concealed by granules, while the largest specimen from the Galapagos Islands (disk diameter 37 mm, arm length 143 mm) has exposed radial shields and five sets of pore pairs. Another series of fifteen specimens from Guaymas Bay, Sonora, Mexico, have concealed radial shields. They range in size from 17 to 35 mm in disk diameter and 51 to 136 mm in arm length. These specimens have the upper arm plates divided into four or five plates basally and two to three distally. The arms are strongly rounded and the color is a uniform brown on the upper surfaces and a lighter brown on the under side.

The smallest specimens were collected at Espiritu Santo Island in the Gulf of California and have a disk diameter of 10 mm and an arm length of 21 mm. In general the smaller specimens have exposed radial shields and fewer divisions of the upper arm plates. The color is a rich chocolate brown on the upper surface with thin black-lined irregular rings on the disk; within the rings the color is a lighter brown. There is definitely no banding of the arms. The color pattern of the upper disk continues on the under interbrachial areas. The mouth parts and the oral shields are lighter brown, the under arms within the disk diameter rich golden-

yellow, fading gradually to the arm tips and blending into the chocolate brown of the upper arm.

Six specimens from the Galapagos Islands differ in having a more pentagonal disk and more delicate arms, with an average arm length of 2.8 times the disk diameter. The upper disk is a reddish-brown without any markings or black-lined rings. The under side is a lighter reddish-brown without markings and the arms are of the same color. The typical robust chocolate brown phase with black-lined rings on disk and golden-yellow under arms was also found in the Galapagos Islands.

Three individuals taken at Port Utria, Colombia, are of the heavy robust form with arms three times the disk diameter in length. The upper disk is brown, uniformly speckled with a light tan, the specks becoming larger distally and extending out on the upper arms to the tips. The spots on the upper arm plates are in two transverse rows running across the arm. Basally there are about 20 spots on the upper arm segment, reducing proportionately to about 12 distally except for the extreme arm segments. The under disk and oral shields are speckled and the mouth parts and under arms are yellow, the color blending distally into the brown of the upper surface. The southernmost specimens from La Plata, Ecuador, are typical in form and have the characteristic chocolate brown disk with thin black-lined rings inclosing areas of lighter brown on both the upper and under disk. The mouth parts and basal arm plates have the golden-yellow coloring.

The color of *O. teres* varies usually according to geographical location and habitat, though several color phases have been taken at the same location. Therefore the writer does not believe it is justifiable to distinguish each color phase as a variety or subspecies as H. L. Clark (1940, p. 342) did for the large size adult, which is uniformly dark brown. Adult dark brown specimens in the Hancock Collection have been taken from the west coast of Baja California, Mexico; Gulf of California, Mexico; and the Galapagos Islands.

One may summarize the most distinctive characteristics of *O. teres* as:

1. Fragmentation of the upper arm plates, becoming more pronounced in the larger specimens.
2. Higher, more pronounced rounded arms, especially in the larger specimens, in contrast to the flat arms of *O. panamense.*
3. The brown color, without arm banding, even in the youngest specimens.

6. *Ophioderma cinereum*

Ophioderma cinereum Müller und Troschel, 1842, Syst. Ast., p. 87.

Ophioderma antillarum Lütken, 1859, Norsk Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 190, pl. 1, figs. 1a-1c.

Ophiocryptus hexacanthus H. L. Clark, 1915, Jour. Entom. Zool., vol. 7, p. 64; 1918, Bull. Mus. Compar. Zool., vol. 62, p. 337.

Ophioderma cinereum H. L. Clark, 1915, Mem. Mus. Compar. Zool., vol. 25, p. 301.

Littoral to 94 fathoms. Florida to Brazil, Gulf of Mexico, Caribbean area, Bermuda, Puerto Rico, and Caledonia Bay, Panama. Common. 116 specimens in Hancock Collection.

7. *Ophioderma longicaudum*

Asterias longicauda Retzius, 1805, Diss. Ast., p. 28.

Ophioderma longicaudum Müller und Troschel, 1842, Syst. Ast., p. 86 pl. 9, fig. 1.

Littoral. Mediterranean Sea, Spain, and Azores. Common. One specimen in the Hancock Collection.

8. *Ophioderma pallidum**

Ophiura pallida Verrill, 1899, Bull. Nat. Hist., Iowa Univ., vol. 5, no. 1, p. 7, pl. 2, fig. 3.

Ophioderma pallidum H. L. Clark, 1915, Mem. Mus. Compar. Zool., vol. 25, p. 302.

110 to 200 fathoms. Off Havana, Cuba. Rare.

9. *Ophioderma phoenium*

Ophioderma phoenium H. L. Clark, 1918, Bull. Mus. Compar. Zool., vol. 62, pp. 333-335, pl. 6, figs. 1-2; 1933, Sci. Survey of Porto Rico and Virgin Islands, vol. 16, pt. 1, p. 71.

Littoral to 14 fathoms. Buccoo Reef, Tobago Island, British West Indies, and Caledonia Bay, Panama. Rare. Three specimens in the Hancock Collection.

10. *Ophioderma panamense*

Ophioderma panamensis Lütken, 1859, Norske Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 193.

Ophioderma panamense H. L. Clark, 1910, Bull. Mus. Compar. Zool., vol. 52, p. 340, pl. 8, fig. 2.

Ophiocryptus granulosus Nielsen, 1932, Vidensk. Medd. Dansk Naturhist. Foren., vol. 91, p. 334, fig. 38.

Littoral to 10 fathoms. San Pedro, California, south to Payta, Peru; Galapagos Islands, Cocos Island, Guadalupe Island, Socorro Island, Clarion Island and the Gulf of California. Very common. 2389 specimens in the Hancock Collection.

In 1940 a series of 284 specimens of *Ophioderma panamense* ranging in disk diameter from 2.3 to 21 mm and in arm length from 6 to 77 mm was collected on a rocky reef at low tide at Puerto Refugio, Angel de la Guarda Island, Gulf of California, Mexico. In this series, 96 specimens have a disk diameter of 6 mm or less, 30 have 7 mm, and many more have less than 9 mm. A study of the development of the growth of *O. panamense* as illustrated by this series follows.

Specimens with a disk diameter of less than 3 mm are entirely covered with granules except for the outer third of the under arm plates. The length of arms averages 2.3 times the disk diameter, and only four arm-spines are developed at this stage.

Specimens with a disk diameter between 3 and 3.5 mm show less granulation. The granules are lost on the center of the upper and under arm plates, except for the four basal segments. The side arm plates, disk, and mouth parts are concealed by granules and five arm-spines are developed.

Specimens with disk diameters between 3.5 and 4 mm have still fewer granules present. A few distal arm segments, side arm plates, four basal arm segments, and the disk are covered by granules, and there are fewer granules on the mouth parts. The arm length varies from 2 to 2.5 times the disk diameter. The arm-spines are still five in number. The color banding on the arms becomes very distinct at this stage.

At the 4 mm disk diameter stage, the granules are disappearing from the side arm plates, the madreporite becomes prominent and exposed, and a few scattered granules remain on the basal under arm plates. The upper arm plates are practically free of granules. The arms are now 2.5 to 3 times the disk diameter in length. The arm-spines are still five in number but have grown considerably longer.

At the 5 mm disk diameter stage, the oral shields are exposed. The upper and under arm plates are free of granules and only the four basal side arm plates bear granules. The mouth parts still retain much of the

granulation. The arm-spines are longer, but still number only five, with the arm length now averaging 3 times the disk diameter.

At the 6 mm stage only the disk and mouth parts are granulated; all arm plates and the oral shields are free of granules. Six arm-spines are now present and the arm length is 3 to 3.5 times the disk diameter. The white arm banding is confined to the distal third of the arms.

At the 8 mm disk diameter stage, 7 arm-spines appear; at 10 to 11 mm, 8; at 17 mm, 9; and at 20 mm, the full number of arm-spines is present. Specimens exceeding 15 mm in disk diameter have an arm length of 3.5 to 4 times the disk diameter.

The color phases of *O. panamense* have been discussed by Ives (1889, p. 76), Nielsen (1932, pp. 328-330), and H. L. Clark (1940, p. 343). There appear to be three dominant phases with numerous variations. It would be difficult to name sub-species or varieties that would be distinctive in large series, as the color seems to be the only difference in the specimens. Rather than add more names, it is preferable to refer only to color phases.

The commonest and simplest color combination is that observed by Lockington (Ives, 1889, p. 76) in which the disk is brown to olive and the arms greenish, with the arms banded distally with white. There are 3 or 4 white bands in small specimens and up to 8 or more in adults. Some 1740 specimens of this phase were collected in the Gulf of California and south to Tangola Tangola Bay, Mexico. They prefer sandy or muddy inter-tidal areas, still water, tidal pools, lagoons, etc., where they are found in large numbers under rocks, coral clumps, and algae holdfasts. Some specimens have broken upper arm plates and broken and regenerating arms, indicating that they might have been crushed by moving rocks. A few such animals with crushed upper arm plates might be confused with *O. teres*, but the white arm bands are a distinctive character for separating this form. The majority of the specimens of this color phase have concealed, or partially concealed, radial shields.

A second color phase, of which 122 specimens were taken in the Gulf of California, seems to be associated with coral heads or rock shingle beaches usually free of sand and mud and is the most colorful of all littoral species. In general structure it appears heavier and more robust, with stouter arms and with the radial shields exposed except occasionally. This is probably because of its more exposed habitat. At nine stations it was taken along with specimens of the green color phase, the latter being the more numerous. The disk may be brown, gray, green, mottled or splashed with tan, white, yellow, old rose, carmine, brown or light green.

Commonly there is a white or cream central splash that may radiate out from the center of the disk. The arms are broadly banded for their entire length in dull gray, green, or slate blue, alternating with 3 to 5 bands of dark brown, maroon, dull rose, reddish-brown or combinations of these colors. Very few specimens are colored alike or have the same pattern. The under side is usually lighter, with faint arm banding seen on some specimens. The under arm plates are light gray, pale yellow, light green or light brown.

Of the third color phase 527 specimens were collected from San Pedro to Cape San Lucas, on rocky exposed coast open to the breakers and the wash of the sea. It is found intertidally under rocks, on ledges, among kelp holdfasts, and in rocky crevices. It has banded arms but the basic color varies according to the latitude. It is noteworthy that it attains a larger size than the other forms, several specimens from the entrance of Newport Bay, California, having a disk diameter of 45 mm and an arm length of 198 mm. The common color pattern of the California west coast specimens is a light tan disk with brown and darker specks in the center, radiating out interbrachially. The radial shields are exposed, with the outer margin bordered by concentric rings of light yellow spots, within which are irregular light spots. The disk at the arm bases is heavily mottled with white. The upper arm plates are pale brown with a fine white transverse line along the proximal edge. Every third or fourth arm segment is a dull white band, covering either one or two segments. The under side of the disk is light brown speckled with yellow and tan. Mouth parts, oral shields and under arm plates are light tan, with only faint traces of the arm banding.

Another series of specimens from a reef 10 miles west of Malarrimo Point, Baja California, Mexico, have a uniform chocolate brown upper disk. The upper arms are chocolate with white to grayish arm bands the entire length of the arms. Distally the bands become lighter and more conspicuous; basally, on older specimens, the banding is inconspicuous and dull. The under side of the disk is grayish-tan, with irregular lighter spots; the under arms are grayish with duller arm banding.

Two large series collected from Turtle Bay, Baja California, Mexico, have a reddish-brown upper disk, becoming lighter brown on the under side and often mottled with cream to gray centrally on the upper surface. The upper arms are reddish-brown with mottled white and gray bands the full length of the arm. The basal arm banding in the adult becomes more inconspicuous with greater size. The oral shields are olive-gray and the under arms light brown, becoming darker distally and with faint banding continuous from the upper arms.

Specimens from Thurloe Bay, Mexico, have a uniform light brown disk, and arms of the same color, with cream and gray mottled bands extending the full length. The under disk is a straw tan, uniform, without any markings. The under arms are light tan proximally, becoming darker distally and showing a faint arm banding.

Specimens from the islands of Clarion and Socorro, west of Mexico, have an olive green disk with brown, reddish, or even cream splotches or central disk markings. The arms are a lighter shade of green, with dark green arm bands basally; distally the arm bands become lighter, almost white at the arm tips. The under disk is light green, often tinged with tan, brown or olive. The under arms and oral shields are light green with creamy mottlings, with the arms becoming darker distally and showing faint banding. The arm bands are conspicuous in the younger forms, but become inconspicuous with increase in size.

Some of the specimens from the Galapagos Islands have the same color patterns as the Clarion Island forms. Smaller specimens lack the green. The disks are reddish-brown uniformly speckled with white, yellow, tan, and brown, giving a salt and pepper effect. The arms are brightly banded with white, gray, and yellow mottled bands alternating with dark brown and slate gray. The under side of the disk also has the specklings over a reddish-brown color, fading into pale yellow proximally. The oral shields and mouth parts are yellow, with the under arms banded proximally with yellow. Distally the bands gradually become as dark as the upper arm bandings.

Specimens of *O. panamense* from Central America are predominately green. The disks are light to dark olive green with tan, gray or light green markings. The arms are darker green with alternating bands of light green which become mottled white and gray distally. The under disk is a yellowish tan proximally, becoming a speckled red and blending into the upper disk coloration. The under arms are a pale green wash which becomes darker distally and shows arm banding. A few forms are more reddish and brown on the upper disk but are still uniformly speckled. Specimens from Bahia Honda, Panama, have light brown disks speckled with lighter tan, yellow and white, with larger irregular chocolate brown markings. The arms are light brown, banded with grayish-cream for the entire length. The under side is light straw tan with faint arm bands.

The South American specimens from the coasts of Ecuador, Colombia and Peru have varying shades of olive green with yellow, tan or light green mottling on the disk. The arms are olive green with inconspicuous arm banding proximally, the bands gradually becoming lighter distally

to a dirty white and very conspicuous. The under disk is cream, yellow, or brown proximally, becoming darker distally and blending into the olive green of the upper disk. The oral shields and under arms are light olive green, with inconspicuous arm bands.

Of the 2389 specimens of *O. panamense* studied, the most consistent character is the banding of the arms, which is present even in the smallest specimen with a disk diameter of only 2.3 mm. In contrast, no specimens of *O. teres* have banding on the arms. For distinguishing these two species the literature gives as characteristics of *O. teres* its relatively short arms, its 9 arm-spines as against 11 for *O. panamense*, its covered radial shield, and the division of the upper arm plates into three to five plates. Only the last character is reliable, though some *O. panamense* display fragmented upper arm plates which are apparently the result of mechanical damage.

The Hancock material shows that the colorful coral-dwelling *O. panamense* has relatively short and heavy arms, supposed to be a characteristic of *O. teres*. Some large specimens of *O. teres* have the radial shields exposed, while others of equal size have them concealed; the common green white-banded Gulf of California phase of *O. panamense* has the radial shields concealed in the majority of specimens. So the exposed radial shield as a characteristic of *O. panamense* is of little value. Finally, the largest specimens of *O. teres* have 13 arm-spines and the largest *O. panamense* have 12, proving that number of arm-spines is an unreliable character.

11. *Ophioderma rubicundum*

Ophioderma rubicunda Lütken, 1856, Vidensk. Medd. Dansk Naturhist. Foren., p. 8; 1859, Norske Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 192, pl. 1, figs. 2a-2c.

Littoral to 9 fathoms. Bahamas, Florida, and Dutch West Indies. Not common.

12. *Ophioderma pentacanthum*

Ophioderma pentacantha H. L. Clark, 1917, Bull. Mus. Compar. Zool., vol. 61, pp. 443-444, pl. 3, pl. 4, figs. 1-2.

25 to 100 fathoms. Galapagos Islands and Gulf of California. Rare. One specimen from the Gulf of California in the Hancock Collection.

13. *Ophioderma elaps*

Ophioderma elaps Lütken, 1859, Norsk Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 195.

Ophioderma clypeata Koehler, 1914, U. S. Natl. Mus. Bull. 84, p. 7, pl. 18, figs. 2, 6.

73 to 300 fathoms. Off Grenadines, Montserrat, Island of Pines, and Galapagos Islands. Rare. One specimen from 73 fms, Galapagos Islands, in Hancock Collection.

14. *Ophioderma leonis**

Ophioderma leonis Döderlein, 1910, Denkschr. Mediz.-Naturwiss. Gesell., vol. 16, p. 252, pl. 5, figs. 1-1a.

Ophiura tongana Lyman, 1882, Challenger Repts., Zool., vol. 5, Ophiuroidea, p. 9, *non Ophioderma tongana* Lütken.

Ophioderma leonis H. L. Clark, 1923, Annals South African Mus., vol. 13, p. 351; Mortensen, 1933, Vidensk. Medd. Dansk. Naturhist. Foren., vol. 93, pp. 381-382, fig. 83.

Littoral to 10 fathoms. Southwest Africa. Rare.

15. *Ophioderma variegatum*

Ophioderma variegata Lütken, 1856, Vidensk. Medd. Dansk Naturhist. Foren., p. 21; Ljungman, 1866, Öfvers. K. Vetensk.-Akad. Förhandl., vol. 23, p. 304.

Ophiura variegata Verrill, 1867, Trans. Conn. Acad. Arts and Sci., vol. 1, p. 254.

Ophioderma variegatum Nielsen, 1932, Vidensk. Medd. Dansk Naturhist. Foren., vol. 91, pp. 330-332, fig. 36.

Seldom littoral, down to 60 fathoms. Usually taken in large numbers in dredge hauls on hard and coralline bottom in 10 to 30 fathoms; a delicate form brilliantly colored in tropical waters. A few specimens were collected at low tide in the Galapagos Islands and the Gulf of California. Gulf of California, Mexico, to Panama, Cocos Island, Socorro Island, Clarion Island, and the Galapagos Islands. Common. 504 specimens in the Hancock Collection.

16. *Ophioderma brevispinum*

Ophiura brevispina Say, 1825, Jour. Acad. Nat. Sci. Phila., vol. 5, p. 149.

Ophioderma serpens Lütken, 1859, Norske Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 198, pl. 1, figs. 6a-6c.

Ophioderma brevispinum H. L. Clark, 1915, Mem. Mus. Compar. Zool., vol. 25, p. 300.

Littoral to 63 fathoms. Massachusetts to Florida, Gulf of Mexico, and Caribbean area. Common. 107 specimens in the Hancock Collection.

17. *Ophioderma januarii*

Ophioderma januarii Lütken, 1856, Vidensk. Medd. Dansk Naturhist. Foren., p. 7; 1859, Norske Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 199, pl. 1, figs. 5a-5c.

Littoral. Tobago Island, British West Indies, and Brazil. Rare.

18. *Ophioderma holmesii*

Ophiura holmesii Lyman, 1860, Proc. Boston Soc. Nat. Hist., vol. 7, p. 255.

Ophioderma holmesii Meissner, 1901, Bronn's Thier-Reich, vol. 2, abt. 3, buch 3, p. 915.

Littoral. Charleston, South Carolina. Rare.

19. *Ophioderma brevicaudum*

Ophioderma brevicauda Lütken, 1856, Vidensk. Medd. Dansk Naturhist. Foren., p. 8; 1859, Norske Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 196, pl. 1, figs. 3a-3c.

Ophioderma brevicaudum H. L. Clark, 1933, Sci. Survey of Porto Rico and Virgin Islands, vol. 16, pt. 1, p. 69.

Littoral. Florida, Bahamas, Dutch West Indies, and Bermuda. Common. 132 specimens in the Hancock Collection.

20. *Ophioderma tonganum**

Ophioderma tongana Lütken, 1872, Overs. K. Danske Vidensk. Selsk. Forhandl., pp. 76, 106; Mortensen, 1933, Vidensk. Medd. Dansk Naturhist. Foren., vol. 93, pp. 381-382.

This species was described from one specimen reported to be from Tonga Island in the South Pacific, where the genus does not occur. The type specimen has been lost (Mortensen, 1933, p. 382); but it is retained in the key until more material is available, as the species seems to be valid and the locality may be incorrect.

21. *Ophioderma appressum*

Ophiura appressa Say, 1825, Jour. Acad. Nat. Sci. Phila., vol. 5, pp. 151-152.

Ophioderma virescens Lütken, 1859, Norske Vidensk. Selsk. Skr., ser. 5, vol. 5, p. 194, pl. 1, figs. 4a-4d.

Ophioderma appressum H. L. Clark, 1933, Sci. Survey of Porto Rico and Virgin Islands, vol. 16, pt. 1, p. 68.

Littoral. South Carolina to Brazil; Bermuda, Haiti, Dutch West Indies, and eastern Atlantic; Senegal and Angola. Very common. 96 specimens in the Hancock Collection.

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