BODY PATTERNING AND FIELD OBSERVATIONS OF *OCTOPUS BURRYI* VOSS, 1950

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BODY PATTERNING AND FIELD OBSERVATIONS OF *OCTOPUS BURRYI* VOSS, 1950

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ABSTRACT

Octopus burryi Voss, 1950 was observed and photographed *in situ* at St. Croix, U.S. Virgin Islands during a saturation dive mission in NOAA's underwater habitat NULS-1. These first observations of the live animal suggest that it inhabits open sand and mud substrates, that it utilizes a fast, efficient burying maneuver to hide and that it is an ambush predator. *O. burryi* exhibited a repertoire of seven body patterns under two broad categories: acute and chronic, depending upon their duration. They were composed of different combinations of the 26 chromatic, textural and postural components. In general these patterns and components are similar to those observed in other members of the genus *Octopus*, but *O. burryi* may be distinguished from them by its very distinctive brown longitudinal arm stripes, poorly developed white frontal spots, grained skin texture, white transverse mantle streak and integumental trellis arrangement. Live coloration and body patterning may be useful in comparative studies of the behavior and taxonomy of octopuses.

Octopus burryi Voss, 1950 is a rarely collected, shallow-water benthic octopus that is only known from 39 preserved specimens. It is an amphi-Atlantic species recorded in the W. Atlantic from North Carolina, the Gulf of Mexico, Bahama Islands and Caribbean Sea to Amapa State, Brazil; in the E. Atlantic it is found in the Cape Verde Islands and along the W. African coast from Senegal to Angola. Collection depths range from 10 to 183 m (Adam, 1960; 1961; 1962; Pickford, 1955; Voss, 1950; 1951[1]). There is only one brief description of the live animal and little is known about its life history. Our observations of *O. burryi* in its natural habitat indicate that this species has a repertoire of body patterns comparable in complexity to the well-studied common octopus, *Octopus vulgaris* (Packard and Sanders, 1969; 1971; Packard and Hochberg, 1977). As noted by Wells (1978), detailed studies of the body pattern repertoire of a variety of octopuses could yield information about phylogenetic relationships as well as pattern importance in visual communication. In this paper we present qualitative observations of the chromatic, textural and postural components that constitute the various body patterns of *O. burryi*, as well as notes on habitat preference and feeding.

MATERIALS AND METHODS

Underwater excursions were made during 7 days of saturation diving from NOAA's Underwater Laboratory System-1 (NULS-1, formerly Hydrolab), a four-person underwater-habitat located 15 m deep in Salt River Bay Canyon on the north coast of St. Croix, U.S. Virgin Islands. *In situ* observations of three *O. burryi*, with mantle lengths (ML) of 31, 15 and 13 mm were made from 3 to 5 September 1978 utilizing SCUBA. Underwater observations were supplemented with photographs taken by Hanlon using a 35 mm Nikon F camera, 55 mm Micro-Nikkor lens and a Rollei E27 electronic flash, all in Ikelite underwater housings. Later laboratory observations of all three animals were made in a 60-l aquarium for 5 days.

[1] See also Palacio, F. J. 1977. A study of coastal cephalopods from Brazil with a review of Brazilian zoogeography. Ph.D. Dissertation, University of Miami. 311 pp.

Field Observations

We found the largest octopus (31 mm ML) at a depth of 20 m in an old half-buried conch shell (*Strombus gigas*) lying in a calcareous sand plain 10 m from the east reef wall of the canyon. The two smaller octopuses were attracted to our 500 w mercury-vapor light during a reef night light station at 23 m depth and were caught as they crawled onto the exposed light bulb. During three days of repeated day and night observations the larger octopus never left the shell. We removed it forcibly in order to identify and photograph it. When pursued it showed a remarkable ability to bury completely under the sand within 3 seconds (Fig. 1H). Upon emerging from the sand the animal was nearly indistinguishable from the surrounding substrate. Previous workers report taking specimens by trawl or dredge in open sand or mud bottoms, a habitat in which little protective cover is generally available. Thus this fast, efficient burying capability may be useful for rapid escape from predation.

We never observed any of the octopuses actively leaving their lair to pursue or attack prey. To observe feeding we supplied three species of crabs to the octopuses. In the field a small calico crab (*Hepatus* sp., approximately 40 mm carapace width), a common sand inhabitant, was dropped near the largest octopus's shell home. The octopus employed an ambush strategy, whereby it waited until the crab came very close before it partially left the shell, grasped the crab with several arms, and pulled it within the shell to kill and eat it. The same attack method was used by all three animals in the laboratory when they were given small *Uca* sp. and *Sesarma* sp. crabs. This feeding behavior is similar to that we have observed in *Octopus joubini* (reported also by Bradley, 1974[2]), which is a relatively passive and secretive octopus compared to the larger active foragers *O. vulgaris* (Maldonado, 1964; Wells, 1978), *Octopus briareus*[3] and *Octopus cyanea* (Yarnall, 1969).

Body Patterning Components

The definitive work on cataloging and analyzing the complex body patterns of *Octopus* has been done by Packard and Sanders (1969; 1971) and Packard and Hochberg (1977); additional descriptive works include Cowdry (1911) and Warren

[2] See also Mather, J. 1972. A preliminary study of the behavior of *Octopus joubini* Robson 1929. Master's Thesis, Florida State University. 118 pp.

[3] Hanlon, R. T. 1975. A study of growth in *Octopus briareus*, with notes on its laboratory rearing, mating, and field behavior. Master's Thesis, University of Miami. 111 pp.

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Figure 1. *In situ* photographs of the same female *Octopus burryi* (31 mm mantle length) taken within a 15 minute period at a depth of 20 m on a calcareous sand/seagrass plain (numbered components are listed in Table 1). A. Swimming over sand while in *uniform light phase*. Color matches the hue and tone of the background. Note the grained skin texture (13), one of the distinguishing characters of this species. B. *Curled arm swimming* while in *uniform light phase*. Note the prominent head and mantle papillae (15 and 16). C. *Acute mottle* shown amidst a sand and seagrass (*Halophila baillonis*) bottom. Note the arrangement of the light and dark components that produce the mottle. D. *Acute mottle* with longitudinal arm stripes (11) that are a diagnostic character of this species. E–F. Lateral and frontal views of the *flamboyant* response to disturbance with *acute mottle*. The eye is well disguised and all of the body papillae are maximally extended (5 and 14). G. Octopus showing the concealing pattern of *acute resemblance* by flattening the head and eyes (22) and wedging between a rock and the sand bottom and assuming the differential colors and texture of the substrate to obscure its form. H. *Acute resemblance* shown while the octopus slowly emerges from the sand/shell substrate into which it had just buried itself.

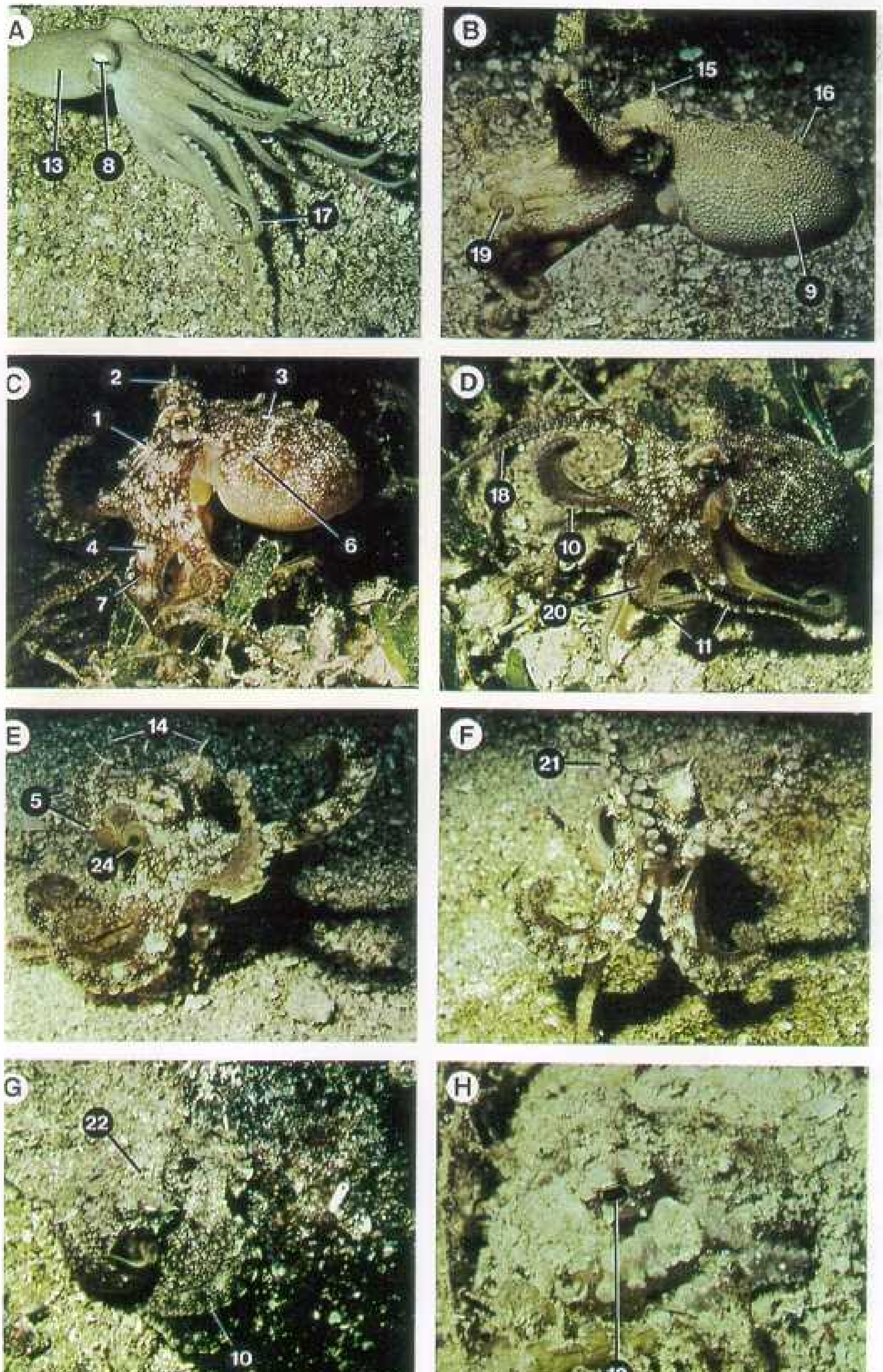

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Table 1. Components and body patterns observed in *Octopus burryi*. The numbers and letters preceding the components and patterns serve as a legend to Figures 1 and 2

COMPONENTS

CHROMATIC

White Components: (1) Frontal spots, (2) Head spots, (3) Mantle spots, (4) Arm bars, (5) White papillae, (6) Transverse streak

Dark Components: (7) Arm bars, (8) Eye bar, (9) Integumental trellis, (10) Dark-edged suckers, (11) Longitudinal arm stripes, (12) Pupil

SKIN TEXTURE

(13) Grained, (14) All papillae raised, including: (15) Long rounded head papillae, (16) Long flattened dorsal mantle papillae, (5) White papillae

POSTURE AND MOVEMENTS

Arms: (17) Loose, (18) Outstretched, (19) Tucked in and curled, (20) Curved, (21) Upturned

Head and Eyes: (22) Flattened, (23) Raised

Funnel: (24) Directed toward external stimulus

Movements (of head, funnel, mantle): (25) Water jetting, (26) Puff of ink

BODY PATTERNS

CHRONIC PATTERNS (sustained for hours or days)

Uniform light phase (Fig. 1, A and B) or *Uniform dark phase*, *Chronic general mottle*

ACUTE PATTERNS (sustained for seconds or minutes)

Concealing patterns: *Acute resemblance* to the substrate (Fig. 1, G and H)

Response to Disturbance: *Acute mottle* (Fig. 1, C through F), *Curled arm swimming* (Fig. 1B), *Flamboyant* (Fig. 1, E and F)

et al. (1974)[2,4]. Packard and Hochberg (1977) have determined that skin patterns of *Octopus* are built up hierarchically from morphological and physiological (1) elements, (2) units and (3) components. The definitions of these terms, as applied to a description of the chromatic and postural repertoire of *Octopus*, require reiteration here. The *elements* are the chromatophores, leucophores and iridophores in the dermis of the skin. They are grouped into skin patches delineated by surrounding skin grooves and are called *units*. These chromatic units are controlled by the nervous system to form either light or dark chromatic *components* that combine with other chromatic components as well as textural, postural and movement components to produce distinct body *patterns*. For detailed explanation of their organization and the principles of patterning in *Octopus*, the reader is referred to Packard and Hochberg (1977).

This paper is primarily an ethogram (Table 1), a catalog of the components and body patterns we have observed in *O. burryi*. Figures 1 and 2 illustrate most of the components and patterns listed in Table 1. For ease of comparison, the format conforms to that of Packard and Sanders (1971). Locomotory movements such as swimming, crawling, sitting and burying are not listed as separate components since their role in patterning and behavior has not been analyzed.

Detailed descriptions of the patterning elements are not now possible because of limited observations. In all species of *Octopus* studied the leucophores are deepest in the dermis and produce the white components (Table 1, Nos. 1 to 6) by reflectance of incident light (Froesch and Messenger, 1978). Iridophores,

[4] Wolterding, M. R. 1971. The rearing and maintenance of *Octopus briareus* in the laboratory, with aspects of their behavior and biology. Master's Thesis, University of Miami. 121 pp.

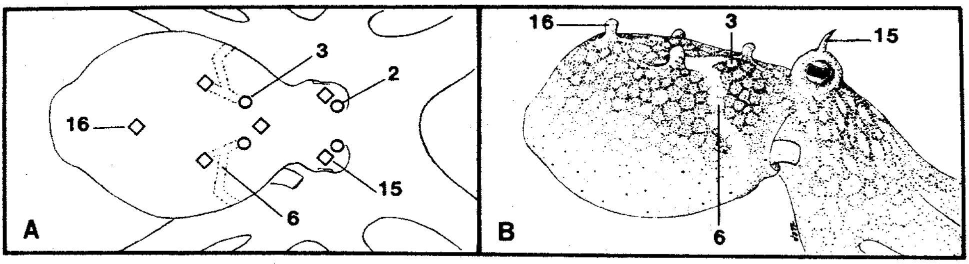

Figure 2. Juxtaposition of the white components and major papillae of the mantle of *Octopus burryi* as seen from above (A) and from the lateral view (B). In the diagrammatic drawing (A) circles represent the two white head spots (2) and the two white mantle spots (3). Diamonds depict the two long head papillae (15) and the four mantle papillae (16). The stippled outline symbolizes the series of prominent leucophores that lead from the mantle spots (3) and constitute the transverse streaks (6).

which lie above the leucophores and reflect blue and green wavelengths, were only slightly evident to us in some photographs. The chromatophores, which are most superficial in the dermis, were predominantly red and brown, though a few yellows and blacks were occasionally seen. The units of *O. burryi* are similar in structure to those of other members of *Octopus* (Packard and Hochberg, 1977) with a system of oval skin patches surrounded by grooves.

Most of the components and patterns in Table 1 and Figures 1 and 2 are self explanatory, but some deserve comment. In *O. burryi* each white mantle spot is relatively small and consists of only one skin patch, or unit, as in *Octopus dofleini* (Packard and Hochberg, 1977: 211). Integumental trellis (Fig. 1B, No. 9) depicts the trellis-like network formed by the grooves surrounding oval skin patches. Dark-edged suckers (Fig. 1, D and G, No. 10) are readily seen in color transparencies but are less distinct in Figure 1. The raised posture (No. 23, not figured) results when the octopus conspicuously extends its head and eyes upward to view the surrounding area. The posture of directing the funnel toward an external stimulus (Fig. 1E, No. 24) is related to the movement of water jetting (No. 25, not figured) in which the octopus forcibly blows water at a threatening object. The pattern *acute mottle* (Fig. 1, C to F) is very similar in appearance to the conflict mottle pattern of Packard and Sanders (1971) and Packard and Hochberg (1977). The physiological and behavioral bases of conflict mottle are uncertain and are now being investigated (Packard, pers. comm., 1979); hence we have avoided the use of this term in favor of acute mottle.

It is not possible to give a comprehensive list of body patterns since they grade into one another and theoretically there is a great number possible with various combinations of the 26 components. Following the basic methodology of Packard and Sanders (1971) we have listed only seven body patterns under two broad categories: acute and chronic, depending upon their duration. This broad-category, flexible system covers a wide pattern range and allows for the addition of new patterns and comparisons among cephalopods. For example, *acute resemblance* may include any number of combinations of components that promote concealment through differential coloring and body patterning.

The *flamboyant* pattern (Fig. 1, E and F) was observed when the octopus was being pursued over the open sand plain. This pattern was almost identical to that of *O. vulgaris* (Packard and Sanders, 1969: fig. 22), except that the mantle did not take on an ogive shape, and the tips of the first pair of arms were not erratically twisted, but were uniformly coiled. Packard and Sanders (1969; 1971) believe this is primarily a cryptic pattern of juveniles that distracts attention from the shape of the octopus by promoting concealment among seaweeds through disruptive patterning. They also report that in *O. vulgaris* it is seen as a specific response of smaller octopuses to threatening shapes, though on occasion it is seen in adults during experimental conflict situations. We suggest that in *O. burryi* it may serve a threat function, since it was seen over open sand and in form it resembled the "showing the weapon" threat posture described in many animals by Eibl-Eibesfeldt (1970) in which an animal shows all its weapons (i.e. suckers and mouth). Whether the flamboyant is similarly restricted to juveniles of *O. burryi* is unknown, since few specimens have been taken and nothing is known about its growth, maximal size or life span. Of the 39 *O. burryi* specimens reported in the literature the mean mantle length is 41 mm with a maximum of 66 mm, perhaps indicating that the animal we photographed (31 mm ML) was only half grown. The small size may also be the reason we did not see the dymantic pattern, which is a characteristic "response to disturbance" of many cephalopods and supersedes the flamboyant in *O. vulgaris* larger than 5 g (Packard and Sanders, 1971). It is noteworthy however that *O. burryi* has the components necessary to deploy this pattern. For example, the longitudinal arm stripes (Fig. 1D, No. 11) could form the outer dark ring of the dymantic, and the flattened posture could easily be assumed from that in Figure 1D.

The color of live *O. burryi* is variable, depending upon the components that are expressed. In *uniform light phase* (Fig. 1, A and B) most of the chromatophores are retracted and the resulting overall pale color matches that of calcareous sand, which ranges from light gray to white. We noticed no conspicuous blue or green colors, but Dr. Donald R. Moore (pers. comm. in Voss, 1950: 77) reported seeing the live animal "as a uniform light green." In *uniform dark phase* (not figured) the animal's color was predominantly red with little brown present. We saw this phase only in the two small octopuses in the aquarium. Mottled patterns were variegated combinations of white and dark (red-brown) components. The most conspicuous chromatic component we saw was the longitudinal arm stripes (referred to as arm bands by Voss, 1950) in all three animals. They were dark brown, as opposed to the deep purple color reported in preserved specimens. This is a new component that has not been reported in other octopods thus far studied.

In general, there is a striking similarity between the components and patterns seen in *O. burryi* and those described for five other species of *Octopus* by Packard and Hochberg (1977). All have four long mantle papillae, two white mantle spots, dark arm bars, dark eye bars, similarly structured white arm bars and highly variegated mottle patterns. *O. burryi* may be distinguished from other octopuses by its very distinctive longitudinal arm stripes, poorly developed white frontal spots, grained skin texture when in *uniform light phase*, white transverse streak and a distinctive integumental trellis arrangement. It is worth noting the considerable similarity in the way that these shallow-water benthic octopuses of varied habitats and wide distribution use the same basic components to produce patterns. We know that *O. briareus*[3,4] and *Octopus hummelincki* (personal observations) in the Caribbean Sea have similar components and body patterns. When detailed studies on body patterning are conducted in other members of the family Octopodidae it may be possible to determine phylogenetic relationships based upon their shared characters. The different components and patterns may serve as valuable tools in comparative studies of the behavior and taxonomy of octopuses.

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