

A pictorial guide to
BUTTERFLY AND ANEMONE FISHES
of Andaman & Nicobar Islands

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KAMLA DEVI



Zoological Survey of India

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PREFACE

The stunning colour and astonishing behavioural patterns of many coral reef fishes like clowns, butterflyfishes, angelfishes, triggers, etc. have delighted the world since 18th century when man started exploring the underwater world. It was not, however, until the last few decades that the intimate relationship of sea anemone-anemonefish, and the various colour patterns and the ecological significance of butterflyfishes began to be known worldwide. Now a days, the fascinating coral reefs became accessible to increasing tourists, sport-divers, skin-divers, naturalists and marine scientists who have all helped in contributing to the knowledge of fascinating facts about the anemone and butterflyfishes. The development of colours, their range, diversity and amazing colours is unrivalled anywhere in the animal kingdom, except possibly by the insect butterflies and birds.

Almost all large public aquaria have these anemone and butterflyfishes at display. Moreover, these fish have been on top in aquarium fish trade for the past few decades. A collection of butterfly and anemonefishes is more than just a selection of marine creatures for scientific study; it is a thing of beauty in itself. This pictorial guide has been primarily designed to cater the needs of all enthusiasts, underwater observers, and amateur aquarists to researchers and further to understand and appreciate the diversity, ecological significance and the fascinating relationship between sea anemone and anemonefishes of the Andaman and Nicobar Islands. It is hoped that it will add greater pleasure to fish-watchers and ignite new insights into the ecological significance of butterflyfishes and the symbiotic nature of anemonefishes.

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Kamla Devi

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INTRODUCTION

Coral reefs provide refuge for an astonishing variety of invertebrates and fishes. Fishes are undoubtedly the most dominant group on the reefs. They range in size from small gobies to whale sharks, which are occasionally seen near reefs. The colour, pattern and array of shapes, their association with other animals is endless. The variety of behavioral patterns, feeding habits and the ecological role played by these fish is equally fascinating. The most common reef fishes are the eels, anglerfishes, squirrelfishes, pipefishes, seahorses, scorpionfishes, groupers, dottybacks, snappers, sweetlips, batfishes, butterflyfishes, angelfishes, damsels, clownfishes, wrasses, parrotfishes, gobies, blennies, surgeons, rabbitfishes, triggerfishes, leatherjackets, boxfishes, puffers, porcupinefishes, etc. Of these the butterflyfishes are renowned for their stunning colour patterns and graceful swimming movements and the clownfishes (anemonefishes) reputed for their remarkable living association with some sea anemones. The symbiotic relationship between sea anemones and clownfishes have fascinated underwater explorers and biologists since centuries because the sea anemones are invertebrates but the fishes associated with sea anemones are vertebrates.

The living association of clownfishes and some sea anemones was first described by Dr. Cuthbert Collingwood (1868) while making underwater survey on Fiery Cross Reef, off the shores of Borneo. It was their beauty and intimate symbiosis with anemones (Symbiosis, a word that literally means "living together," is used by scientists to describe the relationship between unrelated species of plants and or animals that live in close association) that made them one of the most popular aquarium pets all over the world. Like other sea anemones, the anemones that act as a host to the fishes are totally sedentary. Although individuals of several of the host anemones are found without anemonefish but these fish are never encountered without an anemone. Each anemone constitutes the territory of its associated fish and the anemonefish is rarely moved far from it. When the fish feels threatened, it retreats into its tentacles for shelter. Both the symbionts are extremely

beautiful, making them a prime subject of underwater enthusiasts and photographers.

The anemonefishes are exclusively distributed in the entire shallow tropical waters of Indo-Pacific Region. Presently 28 species of anemonefish have been recognised from their distributional range, whereas the butterflyfishes occur in all tropical seas around coral reefs and about 124 species have been described. With no exception, the tiny group of Andaman and Nicobar Islands located in the Bay of Bengal ($6^{\circ} 45' - 13^{\circ} 45' \text{ N Latitude}$ and $92^{\circ} 10' - 94^{\circ} 15' \text{ Longitude}$) with extensive fringing reefs offer an excellent habitat for many reef fishes particularly butterflyfishes, angelfishes, labrids, scorpionfishes, gobiids, blennids etc., of which the most popular are the anemone and butterflyfishes. About nine species of anemonefishes and thirty three species of butterflyfishes have been recorded from these islands. These fascinating denizens prompted the author to bring out a pictorial guide on the anemone and butterflyfishes of the Andaman and Nicobar Islands. In addition to the diagnostic features of fishes for field identification, general information on geographical and ecological distribution, and published information on the fascinating symbiotic relationship of fish and sea anemones, life history, social structures, biology and ecology of these fishes is synthesised in this guide. It is hoped that this information will generate more interest in amateur researchers, common man, underwater observers, snorkellers and aquarists on the anemone and butterflyfishes, making possible a greater understanding of these fish groups and their role on the coral reef ecosystem.

SCIENTIFIC NAMES : Their Significance

In this guide, both common and scientific names for fishes and anemones are used. The common names are in English, but a scientific name is in Latin. A Latin, or scientific, name consists of two parts— a genus (first letter always capitalised) and a species (never capitalized). Both words are **italicized** or underlined to identify it as being in Latin. All similar species are placed in the same genus. Two species in the same genus are more alike and closely related evolutionarily, than two species in a different genus. A generic name may be used by itself

without a species name, but using species name without a generic name is not permissible as the same specific name may be used for species that belong to different genera.

The current scientific name for each species of fish has been provided. Each binomial scientific name uniquely applies to only one species. The name(s) of the person(s) who described the species and the year in which the description was published, are part of the formal scientific name, but are not always appended to it. If the name of the author is in parentheses, it implies that the species has been shifted from the genus in which it was originally described. For example, Broussonet in 1782 originally named *Forcipiger longirostris* as *Chaetodon longirostris*. Hence, the species is now denoted as *Forcipiger longirostris* (Broussonet, 1782).

SYSTEMATIC ACCOUNT OF BUTTERFLYFISHES

Family : CHAETODONTIDAE

BUTTERFLYFISHES

Butterflyfishes are one of the most popular of reef fishes. Their brilliant colours and spectacular patterns, and graceful swimming movements over the reef are amazing. Scientists, aquarists, photographers and laymen alike have been attracted to these colorful fishes since centuries and the volume of information published on these fish is enormous. These fish represented worldwide by 124 species placed in ten genera, are found primarily on coral reefs and, with few exceptions, strictly reef-associated. Most of the butterflyfishes are found in depths of less than 20 m, but some species are encountered in deeper depths of the reefs, to 200 m. Many of the species are restricted to a relatively small area of the reef and extensively move throughout their home range for foraging. Usually omnivorous, feed on small benthic invertebrates and algae, but many species feed on coral polyps. All adults and their young ones are highly prized aquarium pets throughout the world. One hundred and twenty four species of butterflyfishes belonging to family Chaetodontidae, in ten genera, are recognized so far from world waters (Burgess, 1978). The largest genus, *Chaetodon*, is sub-divided into thirteen subgenera. Most of the species

occur mainly in tropical seas around coral reefs. Butterflyfishes and their counterparts, angelfishes, have generally been considered sub-families of the family Chaetodontidae till recent past. Subsequently, extensive studies by Burgess made them separate families supporting the elevation of the angelfishes to family level (Pomacanthidae).

About thirty three species of butterflyfishes, belonging to five genera, comprising 27% of world species, have so far been reported from these islands. *Chaetodon* is the largest genus representing by twentyfive species followed by *Heniochus* with four species, *Forcipiger* with two species and genus *Chelmon*, and *Hemitaurichthys* each with a single species.

The butterflyfishes are deep bodied, ovate and strongly compressed; mouth small and protractile; teeth long, slender and bristle-like; preopercle without a spine at angle; dorsal fin continuous; dorsal and anal fins covered with scales; caudal fin slightly rounded or emarginated; scales ctenoid. All species are associated with coral reefs and are well known for their stunning colour pattern and graceful swimming movements. Occur in shallow to great depths but most of the species found less than 18 to 20 m depth. Usually solitary or in pairs, occasionally in small schools or large aggregations. Feed on a variety of invertebrates and algae. Some species are exclusively feed on coral polyps. Few species of *Hemitaurichthys* feed on zooplankton. Most juveniles and few adult species show cleaning behavior and pick up parasites of other fishes. Many species are strongly territorial. Throughout the world these fishes are very popular and highly prized aquarium pets.

1. *Chaetodon auriga* Forsskal, 1775 THREADFIN BUTTERFLYFISH

Diagnostic features : D. XIII, 22-24; A. III, 19-21; P. 14-15; V. I, 5; Ll. 33-43. Body slightly oval, caudal fin rounded; anterior dorsal rays prolonged into a filament. Body silvery blue with a pattern of chevron markings on sides; posterior part of body yellow with a large black spot on soft dorsal fin; a black band through eye; caudal and posterior anal fins yellow. Juvenile similar to adults but dorsal fin filament absent.

Size : Attains 20 cm.

Habitat : Shallow rich coral reefs areas; common and abundant. Feed on algae, worms and coral polyps. Good aquarium pet.

Distribution : Indo-West Pacific.

2. *Chaetodon citrinellus* Cuvier, 1831 CITRON BUTTERFLYFISH

Diagnostic features : D. XIV, 20-22; A. III, 16-17; P. 13-14; V. I, 5; Ll. 38-42. Body slightly deep and compressed; caudal fin slightly rounded. Head, body and fins pale yellowish with slightly oblique to horizontal rows of black spots, one per scale; a black band through eye, joining at nape; anal fin with broad black edge. Juveniles similar to adults but the black anal band extending more on anal rays.

Size : Attains 10 cm.

Habitat : On shallow exposed reef areas and reef flats; uncommon. Feed on small benthic invertebrates, algae and sometimes prey on coral polyps. Good aquarium pet.

Distribution : Widespread in Indo-Pacific.

3. *Chaetodon collare* Bloch, 1787 RED-TAILED BUTTERFLYFISH

Diagnostic features : D. XII, 25-26; A. III, 20-22; P. 15; V. I, 5; Ll. 38-40. Body slightly ovate and compressed. Colour brownish to olive, each scale with pale center; snout to postorbital part of head black; a broad white band from nape through opercular margin bordering eye to isthmus, and another stripe around snout before eye, ventral side of snout white; a black horizontal stripe above eyes crossing nape; dorsal fin reddish brown; margin of soft dorsal white; ventral fin blackish; caudal fin scarlet basally with a dark crossband in middle, distal part of fin white. Juveniles almost similar to adults. Dark band of caudal fin narrow, close to base of fin, and outer portion hyaline; a complete dark eye band encircles head, white band behind eye band present.

Size : Attains 15 cm.

Habitat : Around coral reef areas in shallow waters; not uncommon. Feed on worms, small crustaceans and polyps.

Distribution : Indo-West Pacific.

4. *Chaetodon decussatus* Cuvier, 1829
BLACK-FINNED VAGABOND

Diagnostic features : D. XIII, 24-25; A. III, 20; P. 15; V. I, 5; Ll. 36-40. Body compressed and deep. Dorsal and anal fins with blunt angle. Colour whitish with six diagonal lines extending from upper posterior part of head to base of dorsal spines; 11 or 12 similar lines at right angle from previous lines towards anal fin; dorsal, anal, and caudal peduncle and its adjacent areas black; anal fin with yellow stripes; a dark bar through middle of caudal fin; a black band through eye connected at nape; tips of dorsal spines white. Juveniles similar but dorsal and anal fins with hyaline edges, posterior portion of body dark, but bases of dorsal and anal with darker blotches; caudal fin hyaline.

Size : Attains 15 to 20 cm.

Habitat : Very common on shallow protected reefs. Feed on coral polyps, worms, crustacean and algae. Favourite aquarium pet.

Distribution : India and Sri Lanka to Thailand.

5. *Chaetodon ephippium* Cuvier, 1831
SADDLED BUTTERFLYFISH

Diagnostic features : D. XII-XIII, 22-24; A. III, 20-22; P. 15-16; V. I, 5; Ll. 34-40. Body deep, snout slightly produced; anterior few rays of dorsal fin extended into a filament. Body yellowish-grey with a large black area posteriorly on back including soft dorsal fin, and broadly bordered below by white; lower sides of body with wavy narrow blue lines; a small black bar through eye but fade away with age; a vertical dusky line between base of dorsal fin and pectoral base; snout and under side of head yellow; upper and lower edges of caudal fin yellowish. Juveniles slightly vary in form and colour from adults. Dorsal fin filament absent and fin almost right-angled. Eye band complete, united at nape, gradually loses with growth; a narrow black band surrounds caudal peduncle; posterior body saddle present, not prominent.

Size : Attains 22 cm.

Habitat : Found in shallow and protected reef areas in pairs. Feed on small benthic invertebrates, sponges, corals and algae. The most beautiful and popular aquarium fishes.

Distribution : Indo-Pacific.

6. *Chaetodon falcula* Bloch, 1793

SICKLE BUTTERFLYFISH

Diagnostic features : D. XII-XIII, 24-25; A. III, 20-21; P. 15-16; V. I, 5; Ll. 29-34. Snout elongate. Body yellow, slightly lighter below with two triangular black blotches dorsally; a broad black band from nape through eye to isthmus; several vertical narrow black lines on body; black band around caudal peduncle; dorsal, anal and caudal fins yellow with sub-marginal black band; pectoral and ventral fins pale yellow. Juveniles similar to adults in form and colour pattern.

Size : Attains 20 cm.

Habitat : Around rich coral reef areas in shallow waters; not uncommon. Feed on small invertebrates, algae and coral polyps. Good aquarium pet.

Distribution : Indo-West Pacific.

7. *Chaetodon guttatissimus* Bennett, 1833

PEPPERED BUTTERFLYFISH

Diagnostic features : D. XIII, 22; A. III, 16-18; P. 14; V. I, 5; Ll. 36-41. Body pale to whitish with small dark spots arranged in rows, the spots extending onto dorsal and anal fins; a dark band around caudal peduncle; a black band from nape through eye to lower opercular margin; black vertical bar at middle of caudal fin; margin of dorsal and anal fins light yellow. Juveniles similar in pattern and colour to adults.

Size : Attains 10 to 15 cm.

Habitat : Outer reef slopes, in sheltered coral reef areas; uncommon. Feed on invertebrates and coral polyps. Good aquarium pet.

Distribution : Widespread in Indian Ocean.

8. *Chaetodon kleinii* Bloch, 1790
WHITESPOTTED BUTTERFLYFISH

Diagnostic features : D. XIII, 20-23; A. III, 18-20; P. 13-14; V. I, 5; Ll. 34-40. Body discoid and compressed. Anterior half of body white, posterior half yellowish brown; a brown bar across anterior whitish area; centers of each scale with large pale spot; a black bar through eye, joined at nape, and continued to black ventral fins; upper dorsal side of body and dorsal fin bluish; soft dorsal, anal and caudal fins yellow; tip of snout black. Juveniles similar to adults but caudal fin broadly hyaline and a pale band around caudal peduncle.

Size : Attains 10 to 14 cm.

Habitat : Around outer coral reef areas, not uncommon. Mainly feed on soft corals and other invertebrates.

Distribution : Widespread in Indian and Pacific Oceans.

9. *Chaetodon lineolatus* Cuvier, 1831
LINED BUTTERFLYFISH

Diagnostic features : D. XII, 25-26; A. III, 21-22; P. 16; V. I, 5; Ll. 26-32. Snout long and narrow; rostro-dorsal profile deeply concave above eye; dorsal and ventral profiles equally convex. Body white with black lunate band along base of soft dorsal fin and extending across caudal peduncle to posterior anal rays; a series of 18 to 20 vertical black lines across sides of body; a prominent black band through eye and partially interrupted on front above eye; median fins bright yellow; two reddish longitudinal lines on soft dorsal and anal fins and transverse lines on caudal peduncle. Juveniles slightly vary in colour pattern. Eye band narrower and lack light spot on nape, lunate band very diffuse, dorsal and anal fins with narrow black edges.

Size : Largest species of the family, attains 30 cm.

Habitat : Reef areas in pairs; frequently encountered. Feed on coral polyps and anemones. Beautiful aquarium pet.

Distribution : Indo-Pacific.

10. *Chaetodon lunula* (Lacepede, 1802)
RED-STRIPED BUTTERFLYFISH

Diagnostic features : D. XI-XII, 22-24; A. III, 17-19; P. 15-16; V. I, 5; Ll. 35-43. Dorsal profile of head concave. Body yellow, becoming brown on upper half of sides; series of oblique reddish brown bands on sides of body; a curved broad yellow edged black band from upper edge of gill opening to base of middle dorsal spines; a wide black bar through eye with a white bar behind it, joined at interorbital space; a large black spot across caudal peduncle; caudal fin with sub-marginal black band. Colour pattern of juveniles different from adults. A conspicuous black spot encircled by white ring in soft dorsal fin, a black band around caudal peduncle.

Size : Attains 20 cm.

Habitat : Around coral reef areas in shallow waters; frequently encountered. Feed on nudibranchs, tubeworms, coral polyps, benthic invertebrates and algae. Beautiful aquarium pet.

Distribution : Indo-Pacific.

11. *Chaetodon madagaskariensis* Ahl., 1933
INDIAN OCEAN CHEVERON BUTTERFLYFISH

Diagnostic features : D. XIII, 20-21; A. III, 16; P. 14; V. I, 5; Ll. 36-39. Body oval and disc-like; snout pointed; fin spines stout and pointed; caudal fin emarginated. Body white; a horse-shoe-shaped black mark on nape enclosed in white border, indistinct below; eye band not connected above; posterior part of body yellowish extended from last two dorsal fin spines to posterior edge of anal fin; caudal fin with yellow sub-marginal band; sides of body with chevron markings. Juveniles similar to adults in form and colour.

Size : Attains 12 cm.

Habitat : Around rich coral reef areas; infrequently seen in our area. Good aquarium pet.

Distribution : Indian Ocean.

12. *Chaetodon melannotus* Bloch & Schneider, 1801

BLACK BACK BUTTERFLYFISH

Diagnostic features : D. XII, 18-20; A. III, 16-18; P. 14-15; V. I, 5; Ll. 33-38. Body ovoid and compressed. Colour whitish; anterior half of head, dorsal, anal, ventral fins and anterior caudal fin bright yellow; numerous oblique lines following scale rows on sides ascending posteriorly; upper back dark black; a dark blotch above anal spines; a broken black ring around caudal peduncle; outer half of caudal fin hyaline. Juveniles almost similar to adults except the black band on caudal peduncle wider in center, resembling a spot.

Distribution : Attains 15 cm.

Habitat : Rich coral reef areas; uncommon. Feed on coral polyps. Good aquarium pet.

Distribution : Widespread in Indo-Pacific.

13. *Chaetodon meyeri* Bloch & Schneider, 1801

MEYER'S BUTTERFLYFISH

Diagnostic features : D. XII, 23-24; A. III, 18-20; P. 16-17; V. I, 5; Ll. 48-54. Body bluish white, upper sides of head grey with curved to oblique black bands on sides; yellow edged black bars on snout, through eye and across operculum; chin dark; median fins yellowish with sub-marginal black bands; pectoral and pelvic fins yellow. Juveniles similar to adults but body stripes less curved, steeply descending anteriorly.

Size : Attains 15 to 18cm.

Habitat : Rich coral reef areas in pairs; frequently encountered. Feed on coral polyps. Beautiful aquarium pet.

Distribution : Indo-Pacific.

14. *Chaetodon octofasciatus* Bloch, 1787

EIGHT-STRIPED BUTTERFLYFISH

Diagnostic features : D. XII, 17-19; A. III, 16-17; P. 12-14; V. I, 5; L.38-40. Body high and compressed. Colour overall white with 7 or 8 vertical black bars extending from dorsal edge to ventral edge of body including

eye-band; a black ring around caudal peduncle; ventral and anal fin edge yellow; pectoral and caudal fins hyaline. Juveniles similar to adults but peduncle band more like spots.

Size : Attains 10 cm.

Habitat : Shallow turbid waters near reefs in small groups or in pairs, tolerate low salinities; not uncommon. Feed on small invertebrates. Good aquarium pet.

Distribution : Indo-West Pacific.

15. *Chaetodon ornatissimus* Cuvier, 1831

ORNATE BUTTERFLYFISH

Diagnostic features : D. XII, 25-28; A. III, 20-22; P. 15-16; V. I, 5; Ll. 48-52. Body deep and compressed. Overall whitish with six to seven slightly wider and oblique dark bordered orange bands on sides, ascending posteriorly; light yellow edged black bars on snout, through eye and on operculum; dorsal and anal fins yellowish with narrow submarginal black band; a broad black band in middle of anal fin; caudal fin with marginal and submarginal black band; ventral fin yellowish. Juveniles similar to adults in colour pattern.

Size : Attains 18 cm.

Habitat : Sheltered reefs and caves of rich coral areas in shallow waters; uncommon. Mainly feed on coral polyps and small worms. Beautiful aquarium pet.

Distribution : Sri Lanka to West Pacific.

16. *Chaetodon plebeius* Cuvier, 1831

BLUE-SPOT BUTTERFLYFISH

Diagnostic features : D. XIII-XIV, 16-17; A. IV, 14-15; P. 14; Ll. 36-40. Body ovoid and compressed. Colour light yellow with narrow dark lines along longitudinal scale rows; an elongate blue patch on upper sides of body and a black spot on anterior portion of caudal peduncle; a blue edged black bar through eye; all fins yellow. Sometimes blue lateral patch absent. Juveniles similar in colour pattern to adults, but eye band connected on nape.

Size : Attains 10 to 13 cm.

Habitat : Shallow coral reef areas; very frequently encountered. Feed on coral polyps. Good aquarium pet.

Distribution : Indo-West Pacific.

17. *Chaetodon punctatofasciatus* Cuvier, 1831
SPOT-BAND BUTTERFLYFISH

Diagnostic features : D. XIII, 22-24; A. III, 17-18; P. 14; V. I, 5; Ll. 38-42. Body oval and compressed. Colour yellow dorsally and gradually shading to white ventrally; 7 or 8 purplish black bands made up of spots on upper half, its lower half with dark grey spots; dark edged yellow bar through eye; a black horse-shoe shaped mark on forehead; caudal peduncle and anterior part of caudal fin orangish; rest of caudal fin white with submarginal black band. Juveniles similar to adults but eye band connected with dark nape mark, caudal fin more hyaline.

Size : Attains 10 cm.

Habitat : Occur on reef slopes in pairs; infrequently seen in our area. Feed on coral polyps, algae and small invertebrates. Good aquarium pet.

Distribution : Andaman Sea to Japan and to Palau.

18. *Chaetodon rafflesii* Bennett, 1830
LATTICED BUTTERFLYFISH

Diagnostic features : D. XII-XIII, 22-23; A. III, 18-20; P. 14-15; V. I, 5; Ll. 33-35. Body deep and compressed. Bright yellow with dark scale edges forming a lattice-pattern; a broad black bar through eye; rear part of dorsal with broad sub-marginal black band; a spindle shaped black band in middle of caudal fin; nape light blue before black bar.

Size : Attains 14 cm.

Habitat : Occur in pairs or solitary in sheltered reef lagoons; not uncommon. Feed on worms, coral polyps and anemones. Beautiful aquarium pet.

Distribution : Sri Lanka to West Pacific.

19. *Chaetodon semeion* Bleeker, 1855

DOTTED BUTTERFLYFISH

Diagnostic features : D. XIV, 23-26; A. III, 19-21; P. 15; V. I, 5; Ll. 33-38. Body compressed and deep; dorsal and anal fins rounded, first few rays of dorsal fin produced into a filament. Body yellow to orange-yellow with small black spots form horizontal rows across body; broad black bands along bases of dorsal and anal fins; dorsal fin filament yellow; a black band through eye joined at nape; interorbital area blue; each caudal fin ray with dark line; ventral fins yellow. Juveniles similar to adults but lack dorsal fin filament. Black bands at base of dorsal and anal fins absent, black band on caudal peduncle present.

Size : Attains 20 cm.

Habitat : Outer reef areas in pairs; uncommon. Feed on small invertebrates, corals, etc. Beautiful aquarium pet.

Distribution : Indo-West Pacific.

20. *Chaetodon triangulum* Cuvier, 1831

TRIANGLE BUTTERFLYFISH

Diagnostic features : D. XI-XII, 24-26; A. III, 20-21; P. 13-14; V. I, 5; Ll. 26-32. Body triangular in shape and compressed; snout short and prominent. Body purplish brown with narrow cream coloured angularly bent bars on sides; snout dark brown; three dark bars on head, eye bands join at nape and chest; a dark purplish bar with pale edge across caudal fin; edge of soft dorsal black; ventral fins light yellow; a boomerang-shaped white marking on caudal fin. Juveniles similar to adults.

Size : Attains 15 cm.

Habitat : Occur in large groups around coral reefs, coral rubble and rocky reef areas in shallow waters; very frequently encountered. Feed on coral polyps. Good aquarium pet.

Distribution : Indian Ocean.

21. *Chaetodon trifascialis* Quoy & Gaimard, 1825

CHEVERONED BUTTERFLY FISH

Diagnostic features : D. XIII, 15-16; A. IV, 13-15; P. 14; V. I, 5; Ll. 24-26. Body slightly narrow. Colour whitish with narrow chevron markings on sides; a black bar through eye to nape; caudal fin blackish, margin narrowly yellow; anal fin and margin of dorsal fin light yellow. Juveniles colour pattern slightly varies from adults. Eye band broad with light borders forming continuous band around head; base of caudal fin yellow, and outer portion hyaline; posterior part of body including soft dorsal and anal fins and half of caudal peduncle dark brown.

Size : Attains 15 to 18 cm.

Habitat : Rich coral reef areas; very common. Feed exclusively on coral polyps and mucus; one of the obligatory living coral reef residents. Good aquarium pet.

Distribution : Indo-Pacific.

22. *Chaetodon trifasciatus* Mungo Park, 1797

REDFIN or OVAL BUTTERFLYFISH

Diagnostic features : D. XIII-XIV, 20-21; A. III, 18-19; P. 14-15; V. I, 5; Ll. 30-38. Body oval. Colour golden orange with slightly oblique narrow purplish stripes on sides; a broad yellow edged black bar through eye; snout black; a narrow bluish black curved stripe along preopercular margin; a broad reddish stripe in soft portion of dorsal and anal fins; pectoral and pelvic fins white; yellow edged black bar across middle of caudal fin. Juveniles similar to adults but posterior eye bands and dark chin colour absent; hyaline edge of caudal fin broad, anal fin light with broad dark edge at first anal spine, base of caudal fin yellow, caudal peduncle dark brown.

Size : Attains 15 cm.

Habitat : Protected coral reef areas; most common reef fish. Feed on polyps. Beautiful aquarium pet.

Distribution : Indo-West Pacific.

23. *Chaetodon unimaculatus* Bloch, 1787

TEARDROP BUTTERFLYFISH

Diagnostic features : D. XIII, 21-23; A. III, 18-19; P. 14-15; V. I, 5; Ll. 40-45. Body compressed, snout robust. Body, dorsal, anal and pectoral fins yellow; black eye-band much narrower than eye; posterior margin of dorsal and anal fins narrowly black and crossing caudal peduncle; a large black spot on side of body. Juveniles similar in pattern and colour to adults.

Size : Attains 18 cm.

Habitat : Outer reef areas and reef slopes in pairs; very rare butterflyfish. Feed on coral polyps, soft corals, worms, sponges and algae. Good aquarium pet.

Distribution : Indo-West Pacific.

24. *Chaetodon vagabundus* Linnaeus, 1758

VAGABOND BUTTERFLYFISH

Diagnostic features : D. XIII, 24-26; A. III, 20-21; P. 15-16; V. I, 5; Ll. 34-40. Snout short; dorsal and anal fins with blunt angle. Body orange yellow with narrow slightly oblique purplish stripes; broad yellow edged black band originates in spinous dorsal fin and passes along fin base to caudal peduncle, extending onto middle anal fin base; a reddish transverse line on caudal fin; an yellow edged black bar through eye; snout black; paired fins yellow. Juveniles slightly different from adults. The posterior body band indistinct, large back spot in soft dorsal fin juxtaposed to submarginal line, caudal fin hyaline.

Size : Attains 20 cm.

Habitat : Around thick coral reef areas; common butterflyfish. Feed on coral polyps and small invertebrates. Good aquarium pet.

Distribution : Indo-Pacific.

25. *Chaetodon xanthurus* Bleeker, 1857

NETTED BUTTERFLYFISH

Diagnostic features : D. XIII, 22; A. III, 15-16; P. 14; V. I, 5; Ll. 32-36. Snout pointed. Body whitish, scales edged with dark lines giving

reticulated pattern on sides of body; posterior orange yellow area begins posterior to soft dorsal rays, crosses peduncle area to base of posterior anal fin rays; eye bands well developed but do not join at nape; a white bordered horse-shoe-shaped mark on nape; caudal fin white with broad yellowish submarginal band. Juveniles resemble adults.

Size : Attains 12 cm.

Habitat : Around coral reef areas; not uncommon.

Distribution : Indo-West Pacific.

26. *Chelmon rostratus* (Linnaeus, 1758)

BEAKED BUTTERFLYFISH

Diagnostic features : D. IX, 28-30; A. III, 19-20; P. 14-15; V. I, 5; Ll.49-52. Body deep, snout extremely long and pointed; dorsal and anal fins much elevated. Body white with three broad yellowish orange vertical bars on sides; a narrow black edged orange bar through eye connected at nape; base of caudal fin with a narrow blue edged brown bar; an ocellated large black spot at base of soft dorsal fin; soft dorsal, anal and ventral fins yellowish. Juveniles resemble adults.

Size : Attains 20 cm.

Habitat : Sheltered, shallow turbid waters of reefs; occasionally encountered. Feed on small invertebrates. Beautiful aquarium fish.

Distribution : African coast to northern coasts of Australia and Ryukyu Islands.

27. *Forcipiger flavissimus* Jordan & McGregor, 1898

FORCEPS BUTTERFLYFISH

Diagnostic features : D. XII, 23-24; A. III, 17-18; P. 15; V. I, 5; Ll. 76-80. Body squarish and compressed; snout very long and tubular. Body, dorsal, pectoral and pelvic fins bright yellow; upper half of head and nape upto pectoral base black; ventral part of head and snout pale bluish white; caudal fin hyaline; a black blotch at posterior end of anal fin rays. Juveniles resemble adults.

Size : Attains 20 cm.

Habitat : Around reef caves and sheltered areas of reef slopes; not uncommon. Feed on small invertebrates. Beautiful and popular aquarium pet.

Distribution : Indo-Pacific.

28. *Forcipiger longirostris* (Broussonet, 1782)
LONG-NOSED BUTTERFLYFISH

Diagnostic features : D. XI, 24-27; A. III, 17-20; P. 14-15; V. I, 5; Ll. 68-73. Body squarish and compressed; snout extremely long and tubular. Body, dorsal fin, pectoral and pelvic fins bright yellow; upper half of head and nape up to pectoral base black; ventral part of head and snout pale bluish white; rows of small black spots on chest; caudal fin hyaline; a black blotch at posterior end of anal fin rays. Juveniles resemble adults.

Size : Attains 20 cm.

Habitat : Outer reef slopes; not uncommon. Feed on tentacles of polychaetes, pedicellaria of sea urchins, tube feet of starfishes, hydroids and small crustaceans. A beautiful and popular aquarium fish.

Distribution : Indo-West Pacific.

29. *Hemitaurichthys polylepis* (Bleeker, 1857)
SHY BUTTERFLYFISH

Diagnostic features : D. XII, 23-26; A. III, 20; P. 16-18; V. I, 5; Ll. 68-72. Body compressed and deep; ventral fins long reaching to base of anal fin spines. Colour white with a triangular deep yellow area behind head; head dark brown; entire dorsal fin and small portion below soft dorsal and anal fins yellow; caudal fin and peduncle white; pectoral and ventral fins white. No black band across eye.

Size : Attains 15 to 18 cm.

Habitat : Occur in large numbers in deeper outer reef slopes; not uncommon around islands. Mostly feed on plankton. Good aquarium pet.

Distribution : Indo-West Pacific.

30. *Heniochus acuminatus* (Linnaeus, 1758)

LONGFIN BANNERFISH

Diagnostic features : D. XI, 24-26; A. III, 17-18; P. 15-18; V. I, 5; Ll. 48-56. The 4th dorsal spine and its membrane greatly prolonged and filamentous, often longer than body length; small stout spine in front of each eye. Body pearly white with broad oblique black bands on sides, first band continuous with black pelvic fins and second band ending on posterior half of anal fin; soft dorsal and caudal fins yellow; a black bar connecting eyes; dorsal filament white. Juveniles resemble adults.

Size : Attains 20 to 25 cm.

Habitat : Occur in pairs or solitary in reef areas; most common and found abundant. Feed on zooplankton and benthic invertebrates. Very popular aquarium pet.

Distribution : Widespread in Indo-Pacific region.

31. *Heniochus diphreutes* Jordan, 1903

SCHOOLING BANNERFISH

Diagnostic features : D. XII, 23-24; A. III, 12-18; P. 18; V. I, 5. Body compressed and elevated, sub-rhomboidal, under side of head more rounded; no spines in front of eyes; front of dorsal fin extended as a long filament. Body white with broad oblique black bands on sides, first band extended from first three dorsal spines to belly and second band from posterior dorsal spine to posterior half of anal fin; soft dorsal and caudal fins yellow; ventral fin black; a black bar above eye; ventral edge of anal fin black. Juveniles resemble adults.

Size : Attains 20 cm.

Habitat : Occur in small schools on bottom of coral reef areas; not rare. Feed on zooplankton and benthic invertebrates.

Distribution : Indo-West Pacific.

32. *Heniochus singularius* Smith & Radcliffe, 1911

SINGULAR BANNERFISH

Diagnostic features : D. XI-XII, 25-26; A. III, 18; P. 16-17; V. I, 5; Ll. 53-63. The fourth dorsal spine prolonged into a stout filament; a pair of

bony black knobs on forehead. Body silvery-white with three broad black bands, more diffuse due to pale centers, first eye band broad and connected ventrally, second band continues with black pelvic fins; dorsal and caudal fins yellow; an isolated black band encircling snout; lips white. Juveniles similar to adults.

Size : Attains 20 cm.

Habitat : Occur in pairs or solitary near reef slopes; not uncommon. Good aquarium pet.

Distribution : Indo-West Pacific.

33. *Heniochus varius* (Cuvier, 1829)

HUMPHEAD BANNERFISH

Diagnostic features : D. X-XI, 22-24; A. III, 17-18; P. 14-15; V. I, 5; Ll. 55-62. Body compressed and strongly elevated; a notch on forehead with bony protuberance; a curved sharp horn above eye; fourth dorsal spine prolonged and strong without a filamentous part, its membrane broad. Body dark brown to black with a narrow white bar from upper nape through gill cover to thorax and second oblique white bar from rear spinous dorsal fin to caudal peduncle; snout, ventral and anal fins black; edge of anal fin white; caudal fin and soft dorsal paler; pectoral fins yellowish brown. Juveniles without horns at nape but resemble adults in colour pattern.

Size : Attains 15 to 18 cm.

Habitat : Around thick sheltered coral reef areas; frequently encountered. Very common aquarium fish.

Distribution : Indo-West Pacific.

ECOLOGY AND BIOLOGY OF BUTTERFLYFISHES

Habitat : As Butterflyfishes are primarily reef fishes, their distribution closely related to the distribution of coral assemblages and depth. One would find butterflyfishes on every coral reef in shallow tropical waters. This correlation between butterflyfishes and coral reefs in regard to their distribution may be due to the following factors. The

corals serve as both a hiding place for many invertebrates that form part of the diet of butterflyfishes and as a food source itself. The coral reef with narrow caves and crevices provide ample protection for these extremely compressed butterflyfishes. The physical conditions like salinity, temperature, etc. of both corals and butterflyfishes are almost similar.

Temperature and depth : Butterflyfishes are essentially tropical shallow water fishes occurring almost entirely within the 21°C isotherms of the northern and southern hemispheres. A few are found in comparatively deeper waters (i.e. greater than 30 meters). The seven species of *Chaetodon* comprising the sub-genus *Prognathodes* are normally found at depths ranging from 30 to 60 meters. There are records of some butterflyfishes have been encountered from depths more than 200 meters (Strasburg, 1953).

Salinity : The salinity tolerance of chaetodontids is not precisely known. It is probable that most butterflyfishes are stenohaline in nature (with a narrow tolerance limits). But there are many records of species (ex. *Chelmon rostratus*, *Chaetodon oxycephalus*, *C. rafflesii*, etc.) being captured in brackish water areas such as estuaries. Juveniles of many species of butterflyfishes are found in tide pools where extreme conditions of temperature and salinity occur. It is quite possible that butterflyfishes may only enter pools where there may not be any serious damage to the fish. But it is quite possible that the young butterflyfishes have to withstand, at least temporarily, adverse conditions. Because of the stenohaline nature of butterflyfishes, it is difficult to maintain many species in captivity.

Food and feeding : Butterflyfishes usually feed on small invertebrates, including coral polyps and planktonic copepods, and at least some of them browse on algae appears to be find their food mainly by sight. It is interesting to note that all chaetodontids are diurnal predators, resting quietly near the bottom during night. *Chaetodon citrinellus*, *C. ephippium*, and *C. vagabundus* were classified as omnivores as they graze off coral polyps and algal filaments. *Chaetodon auriga* was found to be a less selective omnivore, feeding on a wide variety of benthic organisms. *Chaetodon trifascialis*, *Chaetodon ornatissimus*

and *C. multinctus* mostly feed on coral polyps where as *C. unimaculatus* and *C. quadrimaculatus* consuming other invertebrates along with the corals. Hobson (1974) observed that *C. lunula* occurred in large aggregations during the day, breaking up at night into solitary individuals or small groups apparently for feeding. Their diet consists mainly of opisthobranch molluscs with other gastropods as a supplemental item. Based on the observations made by Reese (1975) on butterflyfishes, they can be classified into several different categories depending upon feeding habits, effectively reducing the competition among fishes. Some are plankton feeders adapted for picking small animals from the water column. These species occur in rather large aggregations feed from the surface to near the bottom. Some species, such as *C. kleinii*, *Hemitaurichthys polylepis* combine this plankton feeding with selection of small benthic animals and usually remain close to the shelter of the reef.

Certain butterflyfishes feed exclusively on coral polyps without supplementing their diet with any other invertebrates. Even these coral feeders may not be in strict competition with each other since one species may feed on a certain species of coral and another species on a different species of coral. For example, *Chaetodon trifascialis* feeds exclusively on *Acropora*, where as *C. trifasciatus* appears to favor *Pocillopora* and *C. multinctus* feeds mainly on *Porites* (Hobson, 1974; Reese, 1975). Of the more generalized invertebrate feeders, some species feed on small organisms whereas others tear off pieces from the larger benthic animals. The two species of *Forcipiger* are good examples of this type. In addition the elongate snouts enable them to reach a source of food unavailable to the short snouted feeding forms such as *C. auriga*. Adults of *Chaetodon unimaculatus* have a very strong robust snout and mouth, which enables them to tear off large pieces of soft corals, a food item not utilized by other butterflyfishes. *Chaetodon lunula*, on the other hand, may be a nocturnal feeder, preying upon nudibranchs, small invertebrates, and other organisms that come out from shelter after dark (Hobson, 1974). Nothing is known about the feeding habits of relatively deep-water butterflyfishes, certainly they are out of direct competition with the shallow-water species. Even though butterflyfishes are common reef inhabitants and highly competitive for the invertebrate food sources of the reef, by utilizing

different prey organisms at different levels reducing the competition to relatively low levels.

The butterflyfishes are peculiar in their feeding habits by assuming the position that will enable them to get the best angle of attack in relation to the food selected, whether it be on its side, head down, or even upside down. The mouths of chaetodontids are small and the teeth are slender, curved, and numerous. The arrangement of the teeth may differ slightly from group to group, but basically the size of the mouth and the type of teeth are similar in all the species of the family. The only difference is the various prolongations of the snout. The extremely prolonged snout, an adaptation to crevice-type feeding, is found in *Forcipiger* and *Chelmon* enables them to reach into the narrow crevices.

Cleaning behaviour : The parasite-picking behavior is common in many wrasses. Juveniles of many species of butterflyfishes found occasionally removing parasites from other fishes. The juveniles of *Chaetodon auriga*, *C. lunula*, *C. kleinii*, *C. unimaculatus*, *C. ocellatus*, *Heniochus acuminatus* frequently pick parasites of other fishes. Unlike cleaner wrasses, Juvenile butterflyfishes do not maintain a particular cleaning station although they may occupy a certain territory on the reef.

Pairing behaviour : Butterflyfishes move either as individuals, as pairs strongly or loosely bound together, as small groups or some times as relatively large aggregations. Perhaps the most interesting of these groupings is the formation of pairs. Many species of butterflyfishes are normally found in their habitat as pairs. It is suspected that these pairs are male-female pairs, formed early in life, that stay together for purposes of spawning. The question of when or how the pairs are formed is still remains unanswered. Reese (1975) also observed strong pair bonds in *Chaetodon trifasciatus*, *C. unimaculatus*, *C. vagabundus*, *C. ornatissimus*, *C. punctatofasciatus*, and *C. ephippium*. Other species of butterflyfishes usually form schools or large aggregations. These aggregations are mostly feeding type, but sometimes may be involved in spawning. Some species of the genera *Hemitaenichthys* and *Heniochus* are reported to form large aggregations, possibly for feeding (Hobson, 1974). Some species of butterflyfishes that appear solitary, found in pairs only at spawning time.

Aggressive behaviour : Butterflyfishes would not be regarded as aggressive fishes. They are quite defenseless in terms of canine-like teeth or armor. When threatened or anticipated a danger they quickly hide in the crevices or other sheltered areas of the reef. The deep bodies, further enlarged when the spines are raised, makes predation on these fishes more. When they are unable to escape from the scene they will face the danger by keeping the head downward like a bull about to charge and the spines of the dorsal fin fully erect. The attacker is thus presented with an array of pointed spines. When two butterflyfishes show aggression toward each other, both assume the above-mentioned position. In this head-down-fins-raised position, they circle each other until one of the antagonists' folds its spines back and flee from the area.

Zumpe (1964) observed some behavioral postures in a longsnouted butterflyfish (*Chelmon rostratus*). Two conspecifics would orient to each other in a head-to-tail position and then swim quickly around each other. She termed this action as circling or carousel-swimming. The other pattern observed in *Chelmon rostratus* was ramming, wherein one individual actually rams the other on its side. These behavior patterns were seen in all the chaetodontids studied by her, including several species of *Chaetodon*. In nature, probably the most aggressive displays in butterflyfishes will be seen in defense of their territories (Reese, 1974). When another conspecific invades the territory of a butterflyfish, the defender will immediately chasing it from the territory. This type of action is found in strongly territorial species such as *Chaetodon trifascialis*. The territory defended may be directly concerned with feeding. For example, the food of *C. trifascialis* is the coral *Acropora*, and the territory defended is a stand of *Acropora* (Reese, 1974).

Predators : The adult as well as juvenile butterflyfishes fall prey to many of other reef fishes like tunas, groupers, snappers, scorpionfishes, moray eels, etc. Many of the butterflyfishes would appear to fall easy prey to night-hunting predators since they are inactive during the dusk hours. Large pelagic fishes frequently consume. Butterflyfish larvae. The major predators appear to be tunas and dolphin fishes.

Colour and pattern : The color and color patterns of butterflyfishes, and reef fishes in general, have been subjects of many controversial

discussions. The patterns of butterflyfishes remain fixed as adults except in a few species and the colors are changeable only to a very slight degree. This colour change can be seen in *Forcipiger longirostris*, which may vary in color from bright yellow to dark brownish-black. Their patterns and color make them more obvious rather than less conspicuous. In most instances butterflyfishes are easily spotted on the reef. The stunning variety of designs exhibited by butterflyfishes is probably function as recognition devices for conspecifics and other fishes. Species recognition on a coral reef has considerable importance whether it is for territory recognition and/or spawning or other reasons. It is believed that the bright color patterns may function as a warning device in butterflyfishes. The deep body and spiny nature of these fishes make them difficult to eat by predators. It has been reported that the bright colors and patterns of butterflyfishes act as a type of protective coloration in the varied colors of the coral reef environment.

There is general agreement that the eye band, found in most species of butterflyfishes, is protective in function, obliterating the outline of the eye. The "eyespot" in the dorsal fin of many juvenile and adult chaetodontids is supposed to function as a false eye that directs the attacker's attention toward it rather than to the vulnerable eye. Many juvenile butterflyfishes have a dorsal spot that is lost with age (*Chaetodon lunula*), whereas other species retain it throughout life (*C. auriga*). Night coloration in several species of butterflyfishes, slightly differs from daytime patterns (Hobson, 1974), with the basic pattern always easily recognizable. At night several species (i.e. *Chaetodon paucifasciatus*) have a dark spot in the dorsal fin which is absent during the day. In other species the night pattern is one in which the dorsal half of the body becomes very dark with the exception of two white or light spots aligned horizontally on the side. The two light spots have been observed as night patterns in several species (*Chaetodon trifascialis*, *C. citrinellus*, *C. melannotus*, etc.). *Hemitaurichthys polylepis* exhibits the darkening of the body, but with only a single light spot in the upper center of its body (Hobson, 1974). The significance of these nighttime patterns is not known, it may serve in some way to distract predators from these fishes.

Certain groups of species of butterflyfishes have some aspects of color pattern in common. The eyeband of butterflyfishes either dark-bordered or light-bordered. Some eyebands are light-centered, others dark-centered. The bandwidth may vary individually as well as between species groups. One specific aspect of the color pattern can be found in closely related genera of butterflyfishes are the presence of an interorbital stripe. This stripe extends from the nape or between the eyes to the tip of the snout (*Chelmon rostratus*, *Coradion chrysozonus*, and *Chaetodon modestus*). They also have a barred pattern of yellow to orange on a background of white to yellow. Another species complex exhibits the interorbital stripe but not the barred pattern. Ahl (1923) suggested one "Spotted-*Chaetodon*" complex, which was characterized by a yellowish to white background or body color overlaid with dark spots, one per scale, usually in rows following the pattern of the scale rows (*C. miliaris*, *C. citrinellus*, etc.). In another group of butterflyfishes there is a tendency for the posterior part of the body to be colored differently (usually dark) from the remaining portion. This posterior color is often found in combination with a chevron pattern. In *C. trifascialis*, the posterior black area vanished with age. The dark posterior color pattern is also found in some of the non-closely related non-chevron subgenera. In these species (for example: *C. decussatus*) the dark posterior area is not confined to a limited portion of the body as in the above groups. The chevron pattern may vary, becoming a checkerboard pattern.

The juvenile color pattern of butterflyfishes gradually changes in adults. Because of this, so many synonyms have resulted from the naming of various developmental stages of chaetodontids. There are several basic pattern changes that occur with growth. Juveniles of many species of butterflyfishes have a dark spot or sometimes ocellated in the dorsal fin near the angle of the fin. The spot gradually disappears with growth, and it is absent by the time the fish reaches adult stage. *Chaetodon auriga* and certain other species retain the spot throughout life, and in *Chaetodon paucifasciatus*, the spot found only at certain times in adult. A second change common to many butterflyfishes is the loss of a dark band around the caudal peduncle of juveniles (*Chaetodon ephippium*, *C. semeion*, *C. lineolatus*) with age. The eye band, as mentioned above, is quite variable, not only from species to species, but from

young to adult. Some species lack eye bands in all stages of life. Some others (for example: *Chaetodon ephippium*) have in juvenile's stage only. Several species of butterflyfishes have a normally shaped eye band as juveniles, but with age the upper section on the nape becomes separated into a hoof or horse-shoe-shaped marking. The caudal fin color pattern changes in many species from juvenile to adult. Normally the juvenile possesses a dusky or black cross band near the base of the caudal fin. With increasing age, the band becomes darker, increases in width, and the outer hyaline portion becoming reduced to a narrow edge. Very few species of butterflyfishes undergo a complete color change from juvenile to adult. For example in *Chaetodon lunula*, the colour pattern drastically changes with age. Many species undergo almost no change at all when progressing from juvenile to adult. The color pattern is quite useful in determining species identification of butterflyfishes.

Spawning : Information on spawning is very meager and has never been reported from field observations for any species of chaetodontid. Pairing behavior seems to indicate that spawning is accomplished in many species of chaetodontids through single male-female pairs. Some species forming moderate to large aggregations, this may lead to aggregate school-type spawning in open waters. Usually the eggs released are small, numerous, and pelagic. The time of spawning of chaetodontids is not known. Some observations in Hawaii made by Burgess (1978), revealed that the spawning occurs from early February to early March since investigations of the gonads in January revealed that there were several ripe females and nearly ripe males in that area. No ripe individuals were detected in April. The juveniles of many species of butterflyfishes are abundant from June through September; they were conspicuously absent from the same areas during the winter. Therefore the data indicate that the butterflyfishes probably spawn during the winter, with larvae arriving inshore in the spring and early summer.

Larvae : All chaetodontids have a tholichthys larva. It differs from other larvae in possessing bony armor surrounding the head. The other only one family Scatophagidae is presently known to have a tholichthys-like larva. The tholichthys larvae have small dorsal spines, and the pelvic spines are hidden under a ventral bony projection. The post

larvae still retain the bony plates, but the dorsal and pelvic spines are more highly developed. The ventral bony extension is much reduced. Many biologists studied tholichthys larvae of genera *Chaetodon*, *Heniochus*, *Chelmon*, *Hemitaurichthys*, *Forcipiger*, and *Pseudochaetodon*. Studies shown that all are basically similar but do exhibit some generic differences. The tholichthys of *Chaetodon meyeri* and *C. ornatissimus* were unusual in having a bony projection or horn above each eye directed forward. In the early stages the horns are thick and straight, but in the post larvae they become more slender and curved. The transparent head plates remain for at least several weeks after metamorphosis but gradually shrink and disappear.

The pelagic postlarvae of butterflyfishes are silvery in color, similar to many other pelagic larvae of fishes. Within a short period this pelagic coloration changes to the juvenile color pattern. The longest period of time recorded for this change required about 30 minutes. The bony head plates were visible on all individuals at the time of metamorphosis. The plates disappeared completely in about one month although the length of time was apparently species specific. The size at the time of metamorphosis varies greatly from species to species. Species of the genera *Forcipiger* and *Hemitaurichthys* have the largest tholichthys larvae, measuring up to 60 mm standard length at the time of metamorphosis. On the other hand, *Chaetodon trifascialis*, *C. octofasciatus*, and *Chelmon* have the smallest larvae at the time of metamorphosis measuring 9 to 18 mm standard length.

Family : POMACENTRIDAE
ANEMONEFISHES

The anemonefishes of the genus *Amphiprion* is distributed throughout the Indo-West Pacific faunal region except around Hawaiian Islands, Johnston Island, Line, Marquesas, Pitcarin and Easter islands. There are probably several factors affecting the distribution of these fishes. They are probably dependent on their larval stage for dispersal. Therefore, the main factor regulating distribution is the ability of larvae to survive for extended periods till they were carried to suitable shallow reef areas. The distribution and availability of host anemones are also important factors which would affect the distribution of the fishes. These anemones, and their anemonefishes, inhabit only in shallow waters because of the presence of zooxanthellae (dinoflagellates: single-celled, golden-brown algae) within the cells of an anemone's oral disc and tentacles. The zooxanthellae require sunlight for photosynthesis. During the algae's metabolism most of the sugars "leak" and the anemone gains some energy. Because of this reason, the anemones that are host to clownfishes mostly live at depths of no more than about 50m, usually in clear water.

Anemonefishes live in habitats other than reefs also. Many species of host actinians (= sea anemones) live on sand-flats surrounding coral reefs, or even at some distance from reefs. Individuals of some species can also survive in muddy areas, but they generally lack fish symbionts. Most species of host actinians are inconspicuous, unlike their symbiotic fish. In such cases, the best way to locate an actinian is to disturb nearby anemone fish so that it takes refuge in its anemone. The sea anemones inhabits throughout the world's oceans, from cold to temperate waters, and from the shores to deepest trenches. Out of 1000 species or so of sea anemones, only 10 species are host to anemonefishes. They found in many areas of the Indian and Pacific Oceans. Interestingly, all the 28 species of clownfishes associate only with these 10 species of sea anemones. The richest part of the world for these animals is around New Guinea. The numbers of both anemones and anemonefishes diminishes as the distance from this region increases. Typically, a central Indo-West Pacific locality such as

Guam, or Lizard Island on the Great Barrier Reef, has up to five different species of fishes and about an equal number of anemone species. Numbers are even smaller at the peripheries of their range. For example, one kind of fish and three of host anemones are known from the Comoro Islands, and no clownfishes but one host sea anemone species occurs in Hawaii. Whereas in Andaman and Nicobar Islands nine species of clownfish and four species of anemones were recorded.

FISH AND SEA ANEMONE RELATIONSHIP

The sea anemones are related to corals and more distantly to jellyfishes. The common characteristic feature of all these animals is presence of nematocysts, the harpoon-like stinging capsules that sting (jellyfish) or burn (fire coral). The microscopic nematocysts, which are present in the tissue cells, are particularly dense in tentacles and internal structures. The nematocysts of the tentacles function in prey capture and defence while the internal nematocysts are essential to digestion. Each nematocyst consists of coiled fine tubule many times the capsule's length. When the capsule is stimulated the tube shoots out to penetrate or wrap around the animal or target. Many types of nematocysts contain toxins which are striking to predator and prey by or through the everting tubule. The existence and function of nematocysts were well known before the anemonefish symbiosis was brought to light. But the question was how the fish able to survive in an environment that is fatal to most fishes, even some much larger than anemonefishes. A considerable number of scientific papers dealing with the nature of the anemone-anemonefish association are being available. The reviews of Gudger (1947) and Mariscal (1966b and 1970c) are very informative on this subject. Over the years, many biologists have suggested ways in which it might be possible for the fish to survive in its hostile environment. The following were some hypotheses. 1) Tentacles of these particular anemones do not contain nematocysts. 2) The fish do not actually touch the tentacles. 3) The skin of anemonefishes is thicker than normal so nematocysts cannot penetrate it. 4) While a fish is present, the anemone will not trigger its nematocysts. There is a possibility of all these factors. But this cannot be the final solution to the actual system, might be something else more.

Anemonefishes can be maintained easily in aquaria. Experiments made by some scientists showed that both fishes and sea anemones survive when separated from one another. When the partners are reunited and the fish swims into the host's tentacles, it withdraws rapidly, appearing to have been stung. Thus the protection of the fish is acquired, and can disappear. So the fish, rather than the actinian, is responsible for the protection. But a stung anemonefish returns to its host repeatedly, and touching tentacles first to its ventral fins only, then to its entire belly. Slowly, after a few minutes to several hours of such "acclimation" behaviour, the clown is able to rest among the tentacle. Experiments by Davenport and Norris (1958) suggest that the protective agent present in the mucus coating on the surface of anemonefishes protects from the stings of anemone. But, the source of this protective mucus is questionable. One theory suggests that it comes from the host actinian. It is believed that during its elaborate "acclimation" swimming when contact is initially made with its host, the fish smears mucus from the anemone all over itself. So that it does not sting a fish, or any other object, covered in its mucus, thereby chemically camouflaged (Schlichter, 1976). It was also suggested that the fish's normal behaviour of returning to its anemone quite often interpreted as serving to maintain its protective layer of mucus. Some believe that the fish's own mucus has evolved to lack components that stimulate nematocyst discharge. Although all anemonefishes are closely related and share an unusual habitat, they may vary in some aspects of their biology, including how far they move from their host, number of fish occupy a single host, and how many host species they occupy. It was evident from the experiments made by Brooks and Mariscal (1984) that both fish and anemone may be active in forming the symbiosis for at least one combination of fish and anemone species. The resident clownfish probably provide a certain degree of protection for the anemones from the coelenterate-feeding fishes which inhabit coral reefs. Mariscal (1970c) has suggested on the basis of presence of parasitic copepods, which he collected from anemones and gut contents of the fishes, that clownfishes may get rid of the parasites from the host. Some authors have suggested that swimming activity of the clownfishes among the host tentacles may serve to oxygenate the anemone and remove unwanted sediment from the oral disc.

OTHER SYMBIONTS

The organisms that may, but need not, live with those of another unrelated species are termed "facultative symbionts" Those that must, such as clownfishes, are termed "obligate symbionts" Some host actinians harbour a variety of invertebrate and fish symbionts. Mostly the young black damselfish of the genus *Dascyllus trimaculatus* often found with anemones. However, this fish is not considered to be a true anemonefish, because their lives are not dependent on the anemone host. When small, they may live with anemones; as they grow, they become independent and may remain in the immediate vicinity. In addition to *Dascyllus*, other fishes, particularly young wrasses, are sometimes seen closely move around sea anemones, but only members of *Thalassoma* make infrequent contact with the tentacles. Eibl-Eibesfeldt (1965) recorded that the hawkfish, *Cirrhitichthys aprinus* sometimes found close to the anemones and when in danger, take a position alongside them. Some sea anemones outside the tropical Indo-West Pacific have facultative fish associates. For example, no fewer than 30 species of Caribbean fishes may occur in or near anemones. In addition to algal and fish symbionts, some species of sea anemones harbour small shrimps and crabs. In contrast to anemonefishes, much is not known how closely they are associated to the anemones, and whether they are obligate or facultative symbionts.

SEA ANEMONES

Anemones belong to the phylum Cnidaria or also known as Coelenterata. The name Cnidaria applies due to presence of the cnidae, or nematocysts, that are present only and in all the members of this phylum. Coelenterata means "hollow gut," referring to the presence of single body cavity that serves all the functions of the body systems. It has one opening known as mouth through which food, water, and gametes pass in and out. It is surrounded by many tentacles, which are finger-like or filamentous projections, with numerous nematocysts. These tentacles help in capturing food and passing it to the mouth. The members of Class Anthozoa (includes sea anemones, hard and soft corals) live attached to firm objects of the sea floor, or embedded in its sediments. Unlike most other anthozoans, sea anemones lack

skeletons in the body and are solitary but others like corals are colonial and have skeletal structures. Anthozoans such as corals commonly exist as colonies, with many anemone-like individuals called as polyps attached to one another. The members of the other three cnidarian classes may exist as polyps, but additionally or exclusively as medusae. A medusa is free-swimming upside-down polyp lacking a skeleton, with long tentacles (example a jellyfish). The 10 host anemones of the Indo-Pacific are not all closely related to one another. They belong to three different families under Order Actiniaria. The Actiniidae, is the largest family of most common and shore species of sea anemones. Members of *Entacmaea*, *Radianthus* and *Macrodactyla* are belonging to this family. The exclusively tropical Stichodactylidae, with genera *Heteractis* and *Stichodactyla*, is the main host family but there are also some non-symbiotic stichodactylids.

Identifying anemones is very difficult and almost all available publications on anemone identification are technical in nature. Mostly the identification is based on the characters such as arrangement of tentacles, nature of the animal's muscles, and size and distribution of nematocysts. A sea anemone is simple cylindrical animal. The lower, or pedal, end is adapted as a pedal disc, which attaches firmly to a solid object like a coral block or rock. In burrowing forms it may be pointed for digging into soft sediments. The upper unattached end is known as oral disc contains mouth in the center surrounded by hollow tentacles. The tentacles may be few or many, and arranged in radial rows or in circlets. The tentacles are highly diverse, may be short or long, thin or thick, pointed or blunt, globular or tree-like. The number, form, and arrangement of tentacles are very important in identification of genera and species. A thin vertical partitions known as mesenteries extend from the column wall across the central space. Mesenteries also attach on the underside of the oral disc where tentacles arise between them. The oral disc and mouth are visible in anemones having few tentacles. The mouth may be situated on the elevated conical projection in the center of disc, either circular or elongate, and may differ in colour from the oral disc. The oral disc is much broader than the column in many sea anemones. Some tropical anemones have branched projections from the lower column. But most host sea anemones have longitudinal rows of small warts or verrucae in the upper part. Usually

the pigmentation of the warts is different from the rest of the column. Presence or absence of verrucae is an important characteristic feature in defining genera. The colour pattern is highly variable in most sea anemones; hence it has a little diagnostic value. Presence of symbiotic algae may affect anemone colour, either by imparting their own, or by stimulating the animal to produce a pigment that protects the algae against excessive radiation. Because of this reason it is so difficult to detect even the larger sea anemones in their habitat. The anemones kept in aquaria lose their colour within a short time because the symbiotic algae do not survive under artificial conditions. The fish symbionts can be used to identify sea anemones in nature but not in captivity as many fishes can acclimate to most host anemones.

CLASSIFICATION AND IDENTIFICATION OF ANEMONEFISHES

These Anemone fish are well known and popular throughout their range. All anemonefishes belong to Pomacentridae, one of the largest families in order Perciformes, with a record of more than 330 species. Members of this family, commonly known as damselfishes, are almost marine habitants except three species (mainly brackish water and sometimes occur in fresh water), and most species are very abundant in shallow tropical waters, are relatively easy to collect and thrive well in captivity. More than 70% of damselfishes, including anemonefishes, are found in the entire Indo-West Pacific region. The genus *Amphiprion* and *Premnas* constitute the subfamily Amphiprioninae, one of four pomacentrid subfamilies. The other damselfish that occasionally encountered with sea anemones is *Dascyllus trimaculatus* (Subfamily Chrominae). So far 28 species of anemonefishes are recognised from world waters (Fautin and Allen, 1992), of which 9 species are widely distributed in A & N Islands. Along with these species, the other pomacentrid, *Dascyllus trimaculatus*, juveniles as well as adults which are frequently encountered with anemones, is also included in the species accounts.

Colour pattern is one of the most important features for identifying an anemonefish. The other important characters include shape of tooth, scale pattern of head, and body proportions. To link the smallest young with adults, it is necessary to observe a transitional series of

progressively larger fish. This is often possible in the field as species composed of individuals of increasing size usually occur with larger anemones. Underwater photographs help in distinguishing similar species. The information on anemone host(s) and ecological observations are also helpful. Details on the distribution of a species will be useful in identifying it correctly because many "species pairs" for example: *Amphiprion ocellaris* and *A. percula*, share nearly identical patterns.

1. *Amphiprion akallopisos* Bleeker, 1853
SKUNK ANEMONEFISH

Diagnostic features : D.IX, 18-20; A. II, 13; P. 17; V. I, 5; Gr.18-19; Ll. 35-43. Body slightly ovate; teeth close set and incisiform; predorsal scales 25 to 29; caudal fin slightly rounded. Body pink to nearly orange without any crossbars, a narrow white stripe from forehead to beginning of dorsal fin continuing along base of fin.

Size : Maximum length attains 95 to 110 mm.

Similar species : *Amphiprion sandaracinos* is very similar (Distributed from Western Australia to Ryūkyū Islands), but brighter orange in colour, its white stripe is broader and teeth conical.

Host anemone species : *Stoichactis giganteum*, *Heteractis* sp.

Distribution : Widespread in Indian Ocean, from East coast of Africa including Madagascar to Java and Java Sea.

2. *Amphiprion clarkii* (Bennett, 1830)
CLARK'S ANEMONEFISH

Diagnostic features : D. X, 15-16; A. II, 13-14; P.19-20; V. I, 5; Gr. 19-20; Ll. 36-40. Body slightly ovate; predorsal scales 15 to 20, extending middle of orbits; teeth conical; caudal fin slightly emarginated to bilobed. Usually black with variable amount of orange on head, ventral parts and fins; three broad white bars: on head, body, and at base of caudal fin; transition between darker body and bar across caudal fin base usually abrupt; caudal fin white, white with yellow edges or sometimes yellow; juveniles mostly or entirely orange-yellow with only two anterior white bars.

Size : Maximum length attains about 130 mm.

Host anemone species : *Stoichactis giganteum*, *Heteractis* sp. and *Radianthus* sp.

Melanistic variation : Fish that live with *Stichodactyla mertensii* are frequently black except for snout, white bars, and white tail.

Distribution : Widely distributed anemonefish, from the islands of Micronesia and Melanesia (western Pacific) to the Persian Gulf, and from Australia to Japan.

3. *Amphiprion ephippium* (Bloch, 1790) RED SADDLEBACK ANEMONEFISH

Diagnostic features : D. X, 7-18; A. II, 14; P. 19; V. I, 5; Gr.18-19; Ll. 36-42. Body ovate; predorsal scales 23 to 28 extending to front of orbits; caudal fin slightly emarginated to bilobed. Body and fins reddish-orange, a broad black spot or saddle on sides usually covering much of posterior body in mature fish. The black blotch on sides increases in size with age.

Size : Maximum length attains about 120 mm.

Similar species : *Amphiprion frenatus* (Distributed from South China Sea to Japan), *A. melanopus* (western Pacific), and *A. rubrocinctus* (northwestern Australia) are somewhat similar, but all adults have a single white head bar, juveniles may have 2 or 3 bars); in addition, scales on top of head in these species do not extend as far forward as in *A. ephippium*..

Host anemone species : *Entacmaea* sp; *Heteractis* sp. and *Radianthus* sp.

Distribution : Andaman and Nicobar Islands, Thailand, Malaysia, Sumatra, and Java.

4. *Amphiprion frenatus* Brevoort, 1856 TOMATO ANEMONEFISH

Diagnostic features : D.IX-X, 16-17; A. II, 14; P. 18-19; V. I, 5; Gr. 18-19; Ll. 32-44. Body ovate, predorsal scales 18 to 23 extending to about middle of orbits; caudal fin slightly emarginated. Females mainly blackish on sides with red snout, breast, belly, and fins; males usually smaller than females and mainly red overall; a single white bar on head but juveniles with two or three white bars.

Size : Maximum length attains about 140 mm.

Similar species : *Amphiprion rubrocinctus* (northwestern Australia) is very similar in colouration, but its white bar lacks distinctive black outline; head bar in females is not well developed and has an irregular outline, bar is sometimes discontinuous on top of head. *Amphiprion melanopus* (western Pacific) is also similar, but generally has a broader white head bar and black ventral and anal fins.

Host anemone : *Entacmaea* sp., *Radianthus* sp.

Melanistic variation : Only related to sex as mentioned above.

Distribution: Andaman Islands to South China Sea and adjacent areas, northwards to Japan.

5. *Amphiprion ocellaris* Cuvier, 1830 FALSE CLOWN ANEMONEFISH

Diagnostic features : D. XI, 14-15; A. II, 11-12; P. 17; V. I, 5; Gr.15-16; Ll. 36-48. Body oblong; teeth close set and incisiform; predorsal scales 12 to 16, extending to behind rear of orbits; interdorsal region deeply notched; caudal and pectoral fins rounded. Normally bright orange with three broad white bars, middle one with forward-projecting bulge; bars have narrow black margins.

Size : Maximum length attains about 85 mm.

Similar species : *Amphiprion percula* (distributed from northern Queensland and Melanesia) is almost similar, but has 9 to 10 dorsal spines compared to 11 spines in *A. ocellaris*; the spinous portion of dorsal fin in *A. ocellaris* is more elevated compared to *A. percula*). The geographical distribution of these species is totally different.

Host anemone species : *Heteractis* sp, *Radianthus* sp., *Stoichactis giganteum*.

Melanistic variation : Species occur close to Darwin, Australia are almost black except for white bars. It is doubtful whether this melanism is correlated with a particular species of anemone.

Distribution : Andaman and Nicobar Islands (Andaman Sea), Indo-Malayan Archipelago, Philippines, northwestern Australia; coast of Southeast Asia northwards to the Ryukyu Islands.

6. *Amphiprion perideraion* Bleeker, 1855
PINK ANEMONEFISH

Diagnostic features : D. X, 16; A. II, 13; P. 17; V.I, 5; Gr. 18; Ll. 35-43. Body oblong, teeth close set, incisiform; predorsal scles 22 to 24, extending to about front of orbits; caudal fin slightly rounded. Body pinkish orange; fins pale; narrow white head bar and white stripe on top of head beginning between eyes and extending along base of dorsal fin; adult males have narrow orange margin on soft dorsal fin and upper and lower edges of caudal fin.

Size : Maximum length attains about 100 mm.

Similar species : *Amphiprion nigripes* (distributed around Maldives and Sri Lanka) is more reddish and has a black belly and black ventral and anal fins; *A. akallopisos* (Indian Ocean) and *A. sandaracinos* (eastern Indian and western Pacific Oceans) lack white head bar.

Host anemone species : *Heteractis* sp., *Stoichactis giganteum*.

Distribution : Cocos (Keeling) Islands and Christmas Island in the eastern Indian Ocean, Indo-Australian Archipelago northwards to the Ryukyu Islands, Fiji and Micronesia.

7. *Amphiprion polymnus* (Linnaeus, 1758)
SADDLE BACK ANEMONEFISH

Diagnostic features : D. X-XI, 14-15; A. II 13, P. 19; V. I, 5; Gr 18-19; Ll. 36-40. Body slightly ovate; predorsal scales 13 to 15, extending slightly behind rear of orbits; caudal fin slightly rounded. Body dark brown with broad white bar just behind eye and extending ventrally to edge of interopercle; middle of back with white saddle that slants slightly backwards, extending onto posterior part of dorsal fin; snout, lips and breast light brown; caudal fin mainly dark brown with broad whitish margins, the dark part tapering to a point directed posteriorly; all fins dark brown; breast and belly either yellow orange or dark brown.

Size : Maximum length attains about 115 to 120 mm.

Similar species : *Amphiprion sebae* (distributed in Indian Ocean) has a yellow caudal fin.

Host anemone species : *Heteractis* sp., *Stoichactis giganteum*, *Radianthus* sp.

Melanistic variation : Fish associated with *Heteractis* sp. are generally dark except for white bars, caudal fin margin and light brownish snout.

Distribution: Indo-Malayan Archipelago to the Ryukyu Islands; reported from the Northern Territory, Australia.

8. *Amphiprion sebae* Bleeker, 1853 SEBAE ANEMONEFISH

Diagnostic features : D. XI, 14-15; A.II, 13-14; P.19; V. I, 5; Gr.18-19; Ll. 38-43. Body slightly oblong; predorsal scales 12 to 14, extending to level slightly behind rear of orbits; teeth conical; caudal fin slightly rounded. Dark brownish-black with two broad milk-white cross bars, first bar just behind eye and extending ventrally to edge of interopercle and mid-body bar slanting slightly backwards and extending from rear part of dorsal fin to anal fin; snout, breast, and belly yellowish orange; tail yellow or orange.

Size : Maximum length attains about 135 mm.

Similar species : *Amphiprion polymnus* (distributed from Indo-Australian Archipelago to Japan) is closely related species, but has a dark, wedge-shaped mark on caudal fin and mid body bar mostly confined to upper part of body and dorsal fin.

Host anemone species : *Stoichactis giganteum* sp., *Heteractis* sp.

Melanistic variation : Some individuals are entirely dark brownish except for white bars, lacking yellowish orange colour on snout, breast, and belly. It is not clear whether the variation is associated with a particular anemone host.

Distribution : Entire Northern Indian Ocean and southern Arabian Peninsula.

9. *Premnas biaculeatus* (Bloch, 1790) SPINE-CHEEK ANEMONEFISH

Diagnostic features : D. X, 17-18; A. II, 14-15; P. 16-18; V. I, 5; Gr. 19-20. Ll. 42-48. Body ovate; suborbital (cheek) usually with pair of long

spines; opercle and interopercle with few feeble serrations; interorbital naked; predorsal scales 18 to 22; teeth incisiform, small and close set; interdorsal region deeply notched; caudal and pectoral fins rounded. Bright red to brownish-red with two to three narrow white or light grey bars but can be changed rapidly to white if fish is disturbed; the first bar extending from mid-dorsal region ventrally to edge of interopercle; second bar extending to origin of anal fin; third bar, sometimes indistinct, at caudal peduncle; all fins same as body colour. Males much smaller and brighter red than females and with brilliant white stripes. Juveniles may have distinct dark areas near the center of fins.

Size : Maximum length attains about 158 mm.

Similar species : None: the two well developed suborbital spines; uniformly bright red body and narrow white bars separate this from all other anemonefishes.

Host anemone species : *Entacmaea* sp., *Radianthus* sp.

Distribution : Indo-Malayan Archipelago to northern Queensland.

10. *Dascyllus trimaculatus* Ruppell, 1829

THREE-SPOT DASCYLLUS

Diagnostic features : D. XII, 14-16; A. II, 14-15; P. 19-20; V. I, 5; Ll. 17-19. Body oval to roundish; dorsal and anal fins slightly elevated. Body and fins blackish to light greyish; often with a small distinct white spot on upper side and on forehead. The white spot on forehead is also present in young fish.

Size : Attains maximum length of 14 cm.

Similar species : *Dascyllus albisella* (distributed around Hawaiian and Johnston Islands) and *D. strasburgi* (Marquesas Islands) are similar in appearance. Both are endemic to relatively small areas in which *Dascyllus trimaculatus* does not occur. The young of *D. albisella* (and possibly *D. strasburgi*) sometimes associate with anemone *Heteractis* sp.

Host anemone species : Juvenile fish frequently associate with *Entacmaea* sp.; *Heteractis* sp. and *Stoichactis giganteum*.

Distribution : Widespread in tropical Indo-West Pacific from East Africa to French Polynesia, and Australia northwards to Japan.

BIOLOGY OF SEA ANEMONES

Feeding : All sea anemones, like other coelenterates, capture and digest animal prey with their nematocysts. Usually they feed on small fish, sea urchins, shrimps and crabs. They also feed on planktonic items. However, Sea anemones that are host to clownfishes harbour unicellular algae within the cells of their tentacles and oral disc. During the process of photosynthesis of these zooxanthillae some amount of the carbohydrates produced is "leaked" to their host. This is probably the anemone's major source of energy. Generally these animals are not predators; their prey probably consists of animals that bump into them (e.g. fish, sea urchin, etc.). The other source of nutrients may be from wastes released by their symbiotic fish. Some species of anemone are able to absorb nutrients directly from seawater through their thin tissues, and that may be another source of nutrition for these animals.

Locomotion : Once the larvae settle on the suitable substratum most of the anemones rarely move from place to place. Although they are sedentary, they do have the ability to detach from the substratum, partly or entirely in response to predators or unfavorable physical factors. Often an individual glides on its pedal disc, covering a few millimeters in a day, or it may detach entirely, and roll or be carried quite a distance.

Life span : It is difficult to determine the age of a sea anemone, except for those that have been raised in an aquarium. However, studies on some species in field and laboratory have led to estimate ages on the order of many decades and even several centuries. There are several scattered records that showing anemones surviving many decades in commercial aquaria, and the life span of a small sea anemone in New Zealand has been calculated to be over 300 years. The reason for their longevity is not fully known. Due to presence of nematocysts coelenterates are protected quite well. But small anemones may be eaten by many butterflyfishes. It appears to be that large anemones do not have enemies and it is not known what might ultimately kill them.

Reproduction : All coelenterates reproduce sexually. All the host sea anemones have separate sexes. The eggs and sperm are released into the sea where fertilisation occurs and a free-swimming larva develops for several days before settling on a suitable habitat. Many anemone species spawn during full moon or low tide times so that eggs and sperm are in the same place at the same time and produce millions of tiny larvae but very few survive —usually just enough to maintain a stable population. The rest of the larvae are eaten away by many predators. In some species the eggs are not released but are fertilised inside the mother (sperm enter the mother with water which carries food and oxygen), where they grow and released as tiny sea anemones. It is very difficult to encounter small individuals of most host anemones in nature. However, it is not unusual to find large ones with ripe eggs and sperm. Therefore, it is presumed that very few eggs may be fertilised, or few larvae may survive, or young anemones may have high mortality. In addition to sexual reproduction, some coelenterates also undergo asexual reproduction. At very young stage the polyp can divide longitudinally resulting in two smaller individuals. Each individual then grows to an adult. This is quite common for shallow-water individuals, but those in deeper water grow large and do not divide.

BIOLOGY OF ANEMONEFISHES

The life history of many anemonefishes is well studied. Extensive research on anemonefishes was carried out on *A. bicinctus*, *A. chrysopterus*, *A. clarkii*, *A. melanopus*, *A. ocellaris*, *A. perideraion*, and *A. tricinctus* which are all similar in spawning and in subsequent development of eggs, larvae and young.

Courtship : Generally in damsels, one male may mate with many females during a single spawning period, and in subsequent spawnings other females may often be involved. In most species of clownfishes pair bonding is very strong and is correlated by the small size of their territories. These clowns are unique in forming permanent pair bonds that may last for years. Courtship in clownfishes is generally stereotyped and involves different display postures. Few days before spawning, the social interaction between the pairs increases. This type

of interaction involves chasing, fin-erection and nest preparation. The male becomes aggressive and fearless, chasing and nipping his mate. Sometimes remaining motionless in front of or beside her by fully extending all his fins. During the nuptial period, the male selects a nest site, on bare rock close to the anemone or other suitable location where the tentacles of anemone frequently sweep over the nest. Initially the male and subsequently the female join substrate biting at nest site clearing plant material, benthic organisms and debris for laying eggs. Allen (1975) studied the behavioural postures displayed by some of the clown fishes.

Spawning : Usually spawning occurs throughout the year with some seasonal peaks. In areas of subtropical or warm temperate seas reproductive activity is generally occurs during spring and summer when water temperatures are highest. In some areas the spawning is strongly correlated with the lunar cycle; most nesting occurs when the moon is full or nearly so (Allen, 1975). It is presumed that moonlight may help to maintain a high alertness in the male which involves in nest guarding duties. The newly hatched larvae are usually attracted to light. The moonlight may draw the larvae towards the surface, thereby helps in dispersal by waves and currents. Males involve in intensive nest cleaning activity before spawning takes place. Spawning occurs during morning hour and usually lasts from about 30 to 70 minutes or more. The small conical ovipositor of the female is clearly visible during spawning. The eggs are released through the ovipositor when the female swims slowly in a zig-zag manner with her belly slightly touching the nest surface. The male closely follows the mate's path and fertilises the eggs as they are laid. Numerous passes occur during each spawning session. The number of eggs deposited varies from about 100 to over 1000 depending on the spawning experience of the fish and generally the older pairs produce more eggs than newly formed pairs.

Incubation : The eggs are capsule or elliptical-shaped, about 3-4 mm in length, and attach to the nest surface by short filaments. The development of the embryo can be seen clearly through the transparent egg membrane. The yolk sac is red-orange in colour. They incubate six to seven days. During the entire process of incubation, the male

meticulously guards the nest and aggressively chases other fishes from its surroundings, especially egg-eaters such as wrasses. The male frequently fan the eggs with pectoral fins and also remove dead eggs and debris with mouth. The female also sometimes assists the male with his duties.

Larval life : After six or seven days of incubation hatching occurs during night. Hatching during night is very advantageous as many predators are inactive or at rest at that time. Allen (1975) observed in an aquarium that the freshly hatched fish first sink to the bottom, but within a short time, swim to the upper part of the tank. The larvae are about 3 to 4 mm total length and transparent except for a few scattered pigmented spots. The larval period is ranging from about 8 to 12 days compared to the other damselfishes where the larval period is extended for about 6-8 weeks. After a brief period of larval stage, the young fish settles to the sea bottom and begins to acquire the juvenile colour pattern. The metamorphosis completes within a day or so. Larvae of some clownfish can follow a trail of chemicals released by a host anemone, some may locate a suitable host by sight, or simply reach host by chance. In many cases, once the young fish reaches its host it takes several hours to become fully acclimated to the anemone. This acclimation is achieved by a series of slow and gradually longer contacts with the tentacles. Even if the juvenile successfully locate an anemone, the immediate survival of the fish seems difficult. If the host is already occupied by anemonefish, the unusual social behaviour of the inhabitants makes life difficult for new entrants. The strong territorial and aggressive nature of the resident fish drives away the new entrants, who ultimately have to find another anemone or perish in due course.

Sex reversal : The phenomenon of sex reversal is common in anemonefishes. Sex change also occurs in many fishes like wrasses (Labridae), parrotfishes (Scaridae) and among groupers (Serranidae), particularly in the subfamily Anthiinae. They begin adult life as females and later assume more beautiful colourful male phase. However, the unusual aspect of sex reversal in clownfishes is that the change is from male to female. The socially dominant fish in a particular anemone is generally the female whose gonads are functioning ovaries with remnants of degenerate testicular tissue. The smaller male which in

species such as *A. frenatus* and *P. biaculeatus* may be less than half the size of the female, has gonads that are functioning testes but also possess non-functioning ovarian cells. If the dominant female dies or eaten away by predators, the male's gonads disable and the egg producing cells become active. Immediately the largest of the non-breeding individuals becomes the functioning male. This adaptation allows continuous reproduction in the group without losing any breeding time. There is no difference in colouration between sexes in most anemonefishes, except in few cases. The sex-related slight colour difference may occur between sexes of *A. perideraion* and *A. akallopisos*. The margins of the soft dorsal and caudal fins of males of both species are often orange. In *P. biaculeatus*, colour differences may be related more to size than to sex.

Feeding and growth : Most anemonefish are planktonic feeders. Several research findings by many scientists showed that the copepods and larval tunicates are among the most common items found when their stomach contents are analysed. Some anemones like *A. perideraion*, feed on large amounts of algae from surrounding water column. The growth pattern of anemonefishes was found to be very variable for different species and individuals within a species. Small, non-breeding fish are not necessarily young. The rigid social structure exerts a "stunting" effect on growth. Usually socially dominant fish exhibit faster growth than subdominant conspecifics which share the same anemone. In the mated pair, if the dominant female is removed, the male changes its sex to female and grows at an accelerated rate. The new male may grow even faster. No specific data on the longevity of most species of anemonefish is available. But some are recorded to have lived at least 6 to 10 years in nature. The record for captive fish is 18 years, for *Amphiprion frenatus* and *A. perideraion* maintained at the Nancy Aquarium in France (Allen, 1975).

Interaction between fish and anemones : It is important to know whether the relationship is a mutualistic one (where both partners benefit by the association) or a form of commensalism (where the fish obtaining the benefits while the anemone is neither harmed nor benefited. The word symbiosis literally means, "living together," implying no judgment about the benefits or detriments to either partner.

In some countries, however, it is used as a synonym for “mutualism”, a relationship from which both partners gain advantage. In many cases, the relationship appears to be a mutualistic one. The main benefit obtained by the fishes is that of protection. This is quite evident from the fact that the anemone fishes are never encountered in nature without their anemone hosts; this is an obligate association for them. If they are threatened by a predatory fish or disturbed by other intruders, the fish quickly escapes into the cluster of tentacles. Small fish usually exhibit an extremely close relationship, and the juveniles always confine to the oral disc. At night the fishes rest deep among the tentacles and remain there until dawn. Some *Amphiprion* may obtain at least part of their nourishment from feeding on the waste material egested by the anemone (Moser, 1931; Gohar, 1934; Koenig, 1960; Mariscal, 1970a). Mariscal (1966a and 1970c) examined the stomach contents of several *A. akallopisos* and found substantial amounts of zooxanthellae (symbiotic in the anemone tentacles) and nematocysts. This indicates that perhaps this species obtains part of its nourishment by nibbling on the tentacles of anemone. Another possible benefit suggested to the fishes is the removal of external parasites by the stinging cells of the anemones but there is no convincing experimental evidence to support this. But, Mariscal (1970a) noted that captive fishes without their anemones appear to be more susceptible to common aquarium diseases. Mariscal (1966a and 1970c) suggested that the tactile stimulation that the fish receives from the anemone might be of value to its well being. He found that in the absence of an anemone, captive fish tried to simulate this stimulation by “bathing” in the bubbles of the air stream, tufts of algae, or other suitable objects.

It was observed that the anemone neither benefited nor harmed by the fish—they seem to survive perfectly well without fish. Therefore, many biologists have considered this a strictly one-sided relationship. But some experiments made by the biologists in Great Barrier Reef and in Papua New Guinea on host anemone species *Entacmaea quadricolor* revealed that the relationship with its fishes is mutualistic, the partners obviously profit by living together, protecting one another from predators. If the anemonefish or the anemone is removed both may become prey of larger fish. Other, minor benefits could be the fish eating parasites of the anemones, and fanning their hosts to create

increased circulation of water over them and tend to keep other fish away from the anemone.

Specificity : The relationship between fishes and anemones varies with the species of partner. To begin with, of the 28 fishes, only *Amphiprion clarkii* naturally occurs with all the ten host anemones; about a third of the fish are known from a single species of host, and the rest occur with several hosts. What conditions controls, which species occur together and how do they choose are a big question. It is suggested that the fishes, being the shorter-lived and mobile partner anemone, are responsible for this pattern and only species that occur in the same geographical area and have similar ecological preferences live together. In the event of beyond geographical and ecological coincidence, it is believed that the selection of host may be based on an innate preference of the fish or by chance or based on habitat of the host. Whether protection is from fish or anemone mucus—chemical attraction of larval fish to host anemones is theoretically possible, and is consistent with some fishes being general in their host preferences and others being specific. The recognition of chemicals may be innate instinct.

Preference of fish for only certain anemones may be due to competition among fishes for anemones. Once fish of a particular species occupies an anemone, they chase out newcomers of other species. However, if fish of different species settle on anemone almost at the same time, there can be competition. It is believed that fishes with greater host specificity are better competitors than those with less specificity. Occasionally a fish known to be a poor competitor is found in a highly preferred anemone. Once the resident fish grew a bit and settles, it may prevent small individuals of other species from occupying the anemone, particularly competitively superior ones.

MAINTAINING AQUARIUM FOR CLOWNS

Anemonefishes become one of the most popular pets for marine aquarists all over the world because of their brilliant colour pattern, strange behaviour, and the ability to adapt to captivity. However, few species of anemonefishes are commonly found in the aquarium trade, largely due to the remoteness and lack of expert collectors. The False

clown (*Amphiprion ocellaris*) is the most common aquarium trade fish seen all over the world. Philippines, Indonesia, Singapore, and Hong Kong are the major countries supplying the False clown. The other common clown species are *A. clarkii* (Clark's anemone), *A. frenatus* (Tomato clown), and *Premnas biaculeatus* (Spine-cheek Anemone).

Commercial culture of these fish is very difficult but many commercial fish farms all over the world culturing few species in large quantities. Sufficient space, adequate filtration, proper water quality, temperature, shelter, and a nutritious feed are the prerequisites for successful maintenance of anemonefish in aquaria.

Aquarium size : Generally, the largest possible aquarium should be used (at least 300 litres size). Smaller species, such as *A. ocellaris* and *A. percula*, or juveniles obviously require less space than do adults of species such as *A. clarkii*. Clownfishes are often aggressive, particularly those of single species of equal size, frequently fight when kept together but smaller specimens are generally compatible with other reef fishes. The aggressiveness is usually by the presence of an anemone, as the host is regarded as exclusive territory by every fish. For breeding, the pairs should be kept in isolation, or at least avoid community tanks with larger species.

Filtration and water quality : Different varieties of filters from inexpensive subgravel types to expensive state-of-art systems that even automatically monitor dissolved gas levels, temperature etc. Those who usually live near the sea can utilise the seawater safely with little or no filtration. Whatever may be the filtration system used, a system of providing aeration (airstone or bubbler) and circulation is essential. A small electric air pump connected to a sub gravel filter with a bubble tube and one or more airstones is needed as per the requirement. The nitrate levels and salinity conditions are to be checked regularly for making necessary adjustments to maintain "normal" seawater quality.

Temperature : For the well-being of clownfishes in captivity, temperatures existing in their natural habitat are recommended. Most species occur in the tropics, where the water generally ranges from about 25 to 28^o C. Subtropical species can be maintained in slightly cooler waters.

Feed : In nature, anemonefish feed primarily on zooplankton and other algal material. In place of zooplankton, highly nutritional diet prepared with finely chopped raw prawns and fish, and commercial fish food containing vegetable ingredients can be fed in captivity. This should be supplemented with live foods such as brine shrimp, *Tubifex* worms etc. However, freshwater organisms should be given in small quantities to avoid fouling of tank; several small feedings per day are ideal.

Shelter : Small cave or crevice is to be created by arranging rocks or small clay flowerpots in the aquarium for shelter when threatened or disturbed.

Anemones : Captive fish can survive, and even breed, without anemones. Some clownfish adapts successfully to actinians from places such as Hawaii, California, the Caribbean, and the Mediterranean, but for some, this means keeping the aquarium cooler than is optimal for the fish and warmer than is normal for the anemone. The natural hosts are occasionally collected, and sporadically offered for sale, but this practice is to be discouraged. Natural hosts do not survive well, necessitating frequent replacement. Local populations of *Amphiprion* and *Premnas* have become extinct on some reefs in the Philippines because of wanton destruction of habitat with dynamite and removal of anemones by commercial collectors. Elimination of already limited number of suitable hosts not only deprives fishes of their homes, but it means that there is no source of more anemones. Usually actinians are long lived in nature. Moreover, we have never seen very small individuals of most species, so successful reproduction is probably rare for them. It therefore appears that these lovely animals are being harvested much more rapidly than they are able to produce replacements.

Ignorance about their reproductive biology, combined with difficulty in even maintaining them, preclude aquarium breeding of these actinians. In contrast to the fish, tropical sea anemones, including those with which clownfishes live, generally do not survive well under artificial conditions for reasons that are not entirely understood, but that probably have to do with nutrition. Most anemones lose their zooxanthellae after short time in captivity. This phenomenon may be

related to light, but the appropriate wavelengths and intensity are unknown, so the problem is difficult to remedy. It may also be related to the level of nitrogenous and other compounds in the water. Commercial aquaria that are successful at keeping corals circulate the water through beds of algae to remove such animal wastes, as happens in nature. This, of course, requires elaborate lighting and cooling. But even such enterprises generally end up with bleached anemones. Lacking algae and probably a variety of natural nutrients, captive host anemones not only lose their normal colour, they assume shapes and postures not seen in nature. This can make them difficult to identify. For example, tentacles often shrink greatly, which probably means that the animal is living off its own tissues. As mentioned previously, much useful information concerning the intricacies of the anemone and fish relationship has been gained through observation of captive specimens, particularly in large public aquaria. Amateur aquarists can certainly contribute to the knowledge, particularly in the realm of clownfish reproduction, which has been adequately documented for few species only.

Most serious aquarists maintain a logbook for recording notes on unusual and interesting behaviour of anemone and butterflyfishes. Maintaining butterflyfishes in aquaria is equally difficult as of anemonefishes. For those who want to update and acquaint with latest trends in maintaining these fish may consult a number of standard aquarium magazines. The sheer enjoyment of keeping a tank of anemone and butterflyfishes will no doubt ignite the appreciation of nature's marvelous creation.

GLOSSARY

Actinian—sea anemone, from the scientific term for sea anemones, Actiniaria

Cnidarian—member of phylum Cnidaria (also called Coelenterata), the group to which sea anemones, corals, jellyfish, and hydras belong

Coelenterate—member of phylum Coelenterata (also called Cnidaria); see cnidarian

Facultative symbiosis —a relationship in which one partner may, but need not, live with another in order to survive; the relationship of most species of host sea anemones with anemonefishes is, facultative'

Host—one of the partners in a symbiosis, generally the larger one (thus, the sea anemones that are the subject of this book are hosts to both fish and algal symbionts)

Larva (plural larvae) —a developmental stage that hatches from an egg and that typically lives in a different environment, looks entirely different, and eats different food from the adult of the species; oceanic larvae are generally very small, and are planktonic

Metamorphosis—the change from larva to adult

Melanism—a tendency to develop black pigmentation, common in many species of anemonefish

Mutualism—a symbiosis in which both partners benefit

Nematocyst—microscopic, harpoon-like stinging capsule manufactured by all cnidarians (= coelenterates)

Obligate symbiosis—a relationship in which one partner ~ live with another in order to survive; except for a brief planktonic larval stage, anemonefishes are obligate symbionts of sea anemones

Parasitism—a symbiosis in which one partner benefits, to the detriment of the other **plankton**—oceanic plants and animals that drift with the currents; although most planktonic species are small, some, such as jellyfishes, are not

Symbiont—one of the partners in a symbiosis

Symbiosis—literally “living together”, used by scientists to describe the relationship between unrelated species of plants and/or animals that live in intimate association

Taxonomy—the naming of living beings based on their evolutionary relationships to one another

Zooxanthellae—single-cell, dinoflagellate (golden-brown) algae that live symbiotically within the cells of some marine animals such as most reef-forming corals, many tropical and a few temperate sea anemones, some hydroids, and giant clams.

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Fig. 1. *Chaetodon auriga*



Fig. 2. *Chaetodon citrinellus*

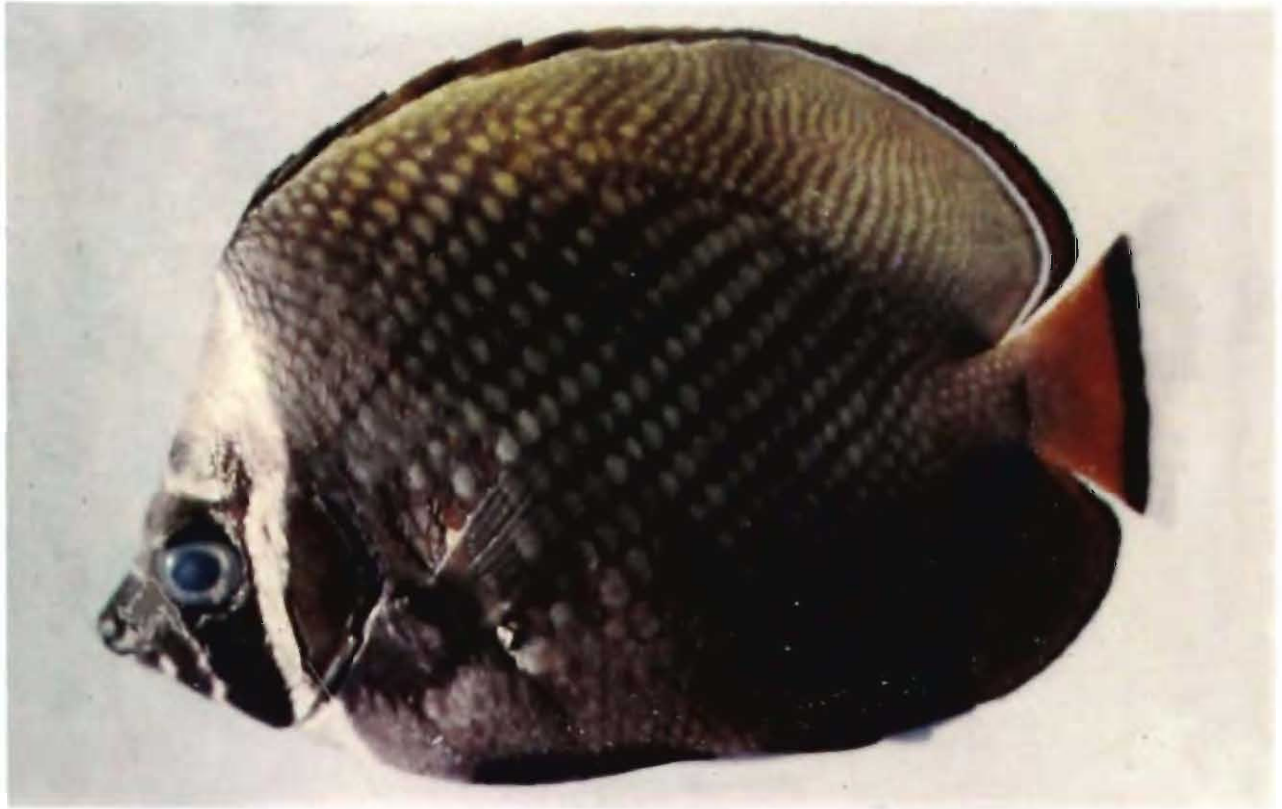


Fig. 3. *Chaetodon collar*

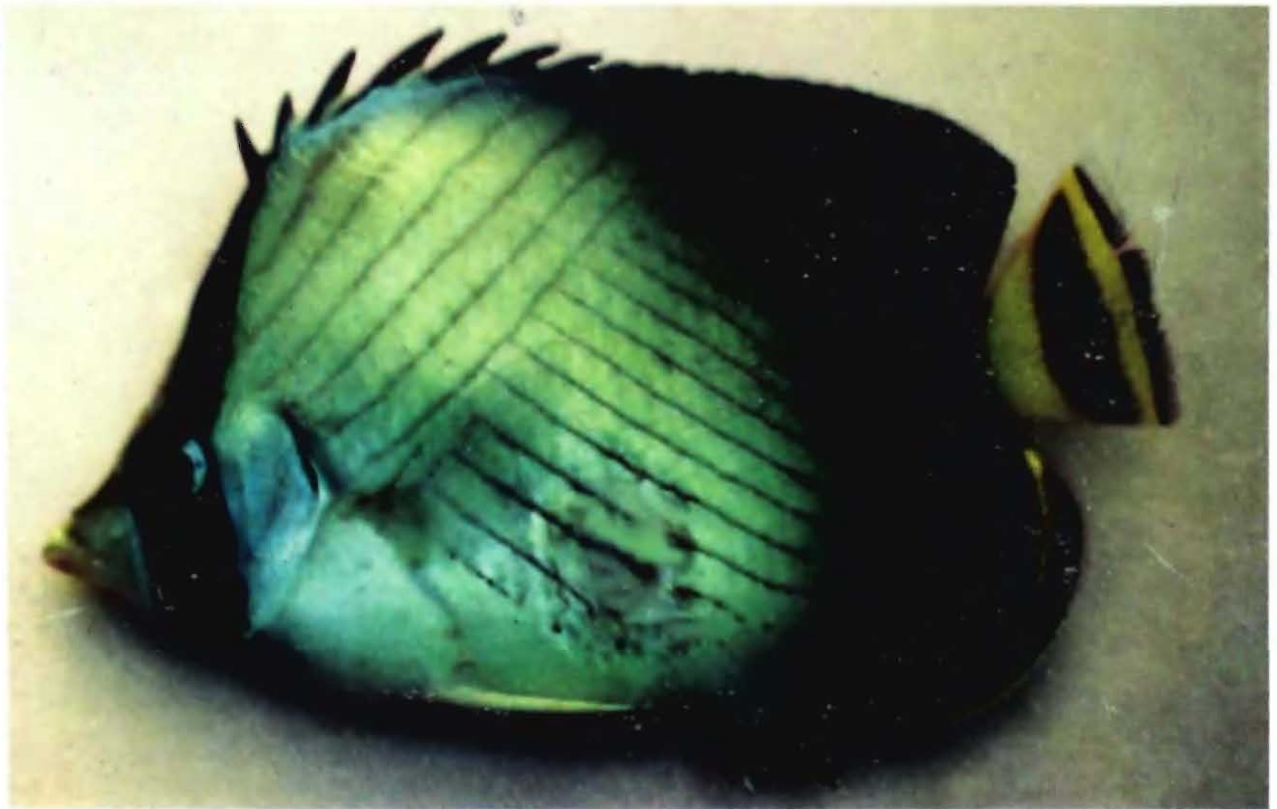


Fig. 4. *Chaetodon decussatus*

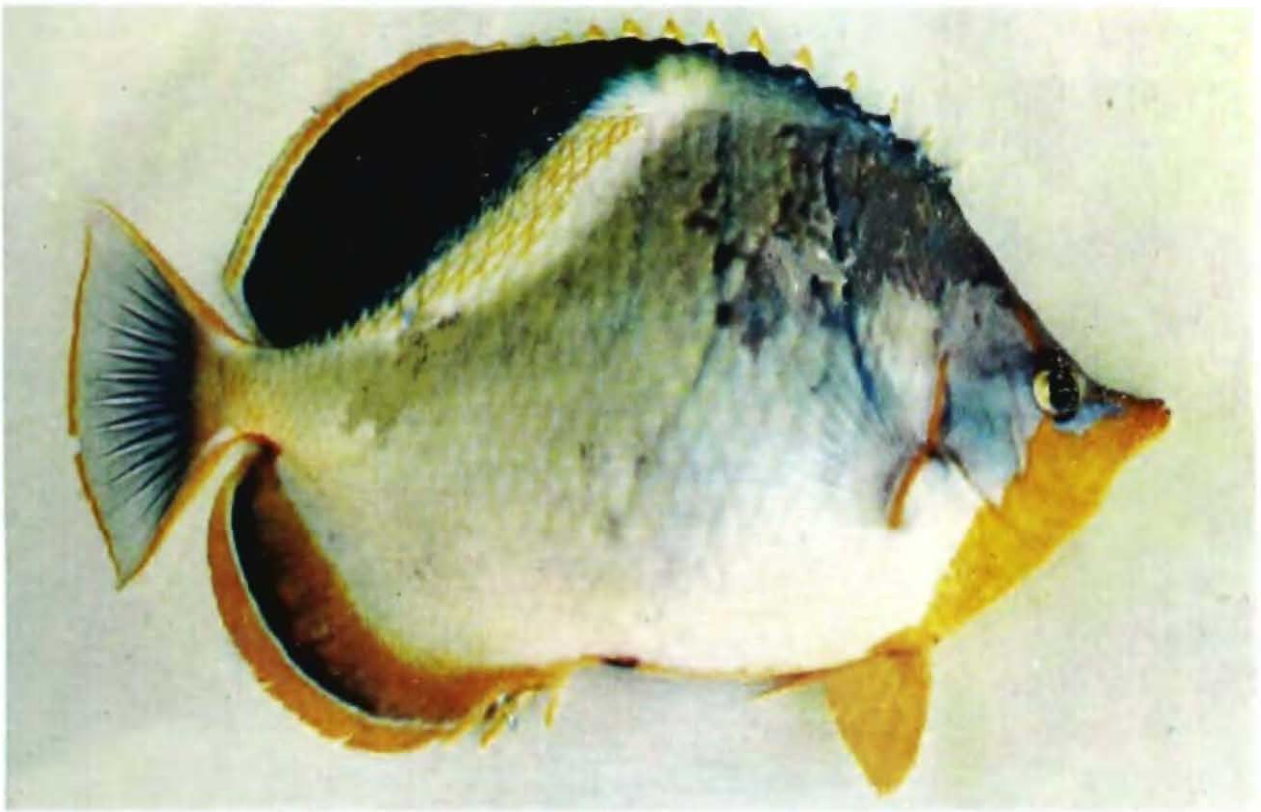


Fig. 5. *Chaetodon ephippium*



Fig. 6. *Chaetodon falcula*



Fig. 7. *Chaetodon guttatissimus*



Fig. 8. *Chaetodon kleinii*



Fig. 9. *Chaetodon lineolatus*



Fig. 10. *Chaetodon lunula*

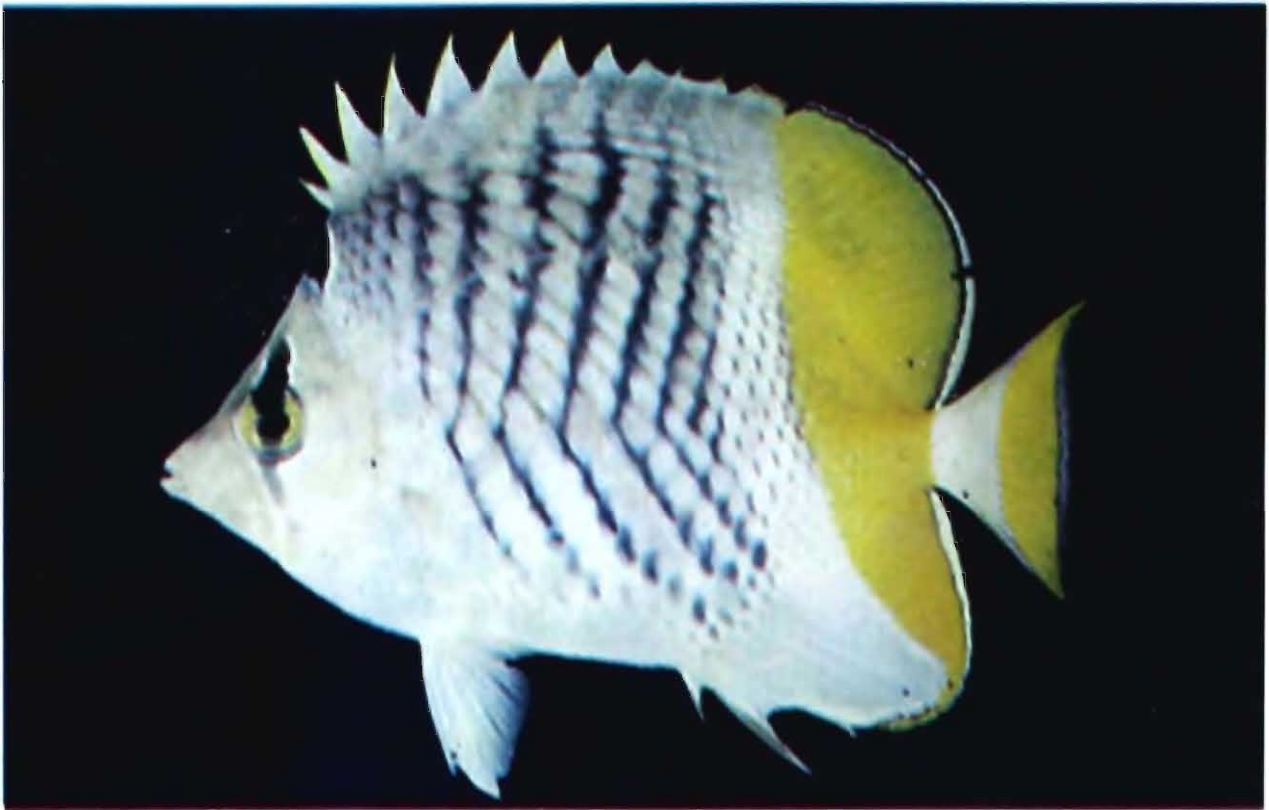


Fig. 11. *Chaetodon madagaskariensis*



Fig. 12. *Chaetodon melannotus*



Fig. 13. *Chaetodon meyeri*



Fig. 14. *Chaetodon octofasciatus*

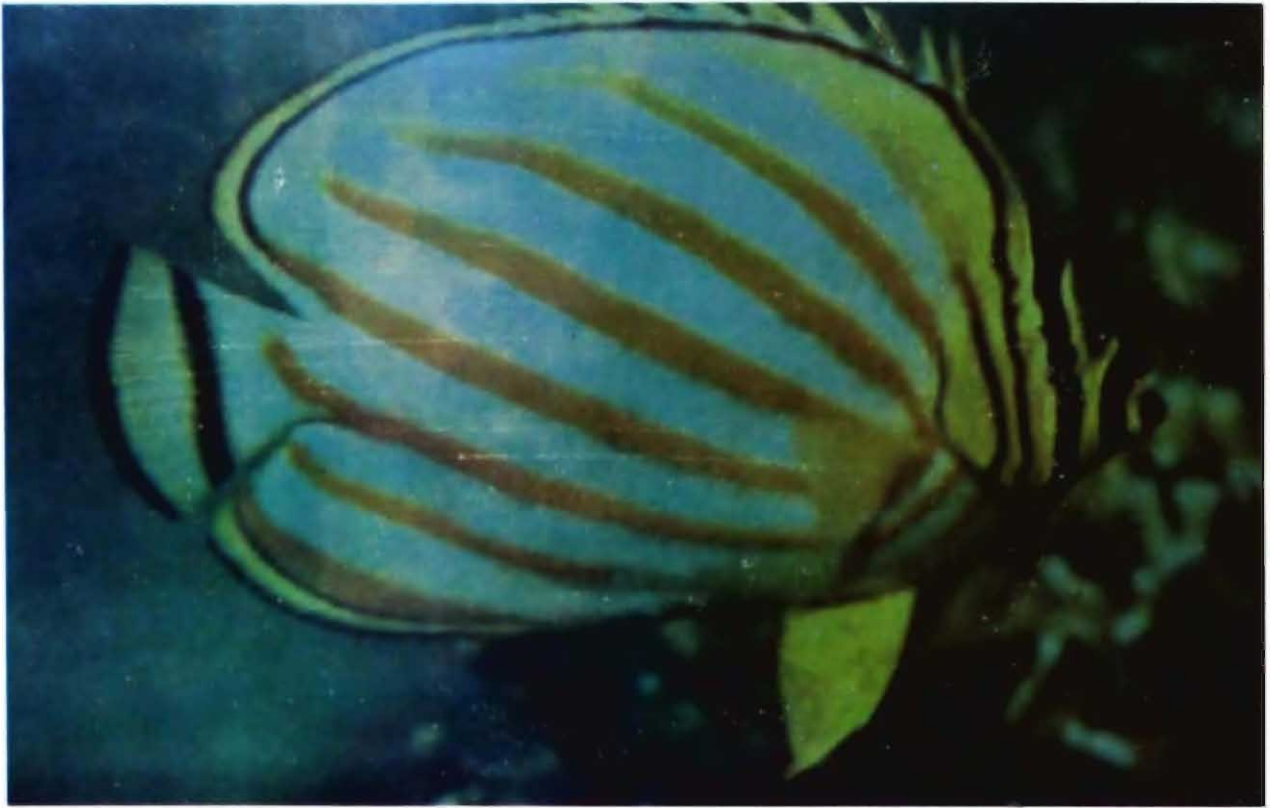


Fig. 15. *Chaetodon ornatissimus*



Fig. 16. *Chaetodon plebeius*



Fig. 17. *Chaetodon punctatofasciatus*



Fig.18. *Chaetodon rafflesii*



Fig. 19. *Chaetodon semeion*



Fig. 20. *Chaetodon triangulum*

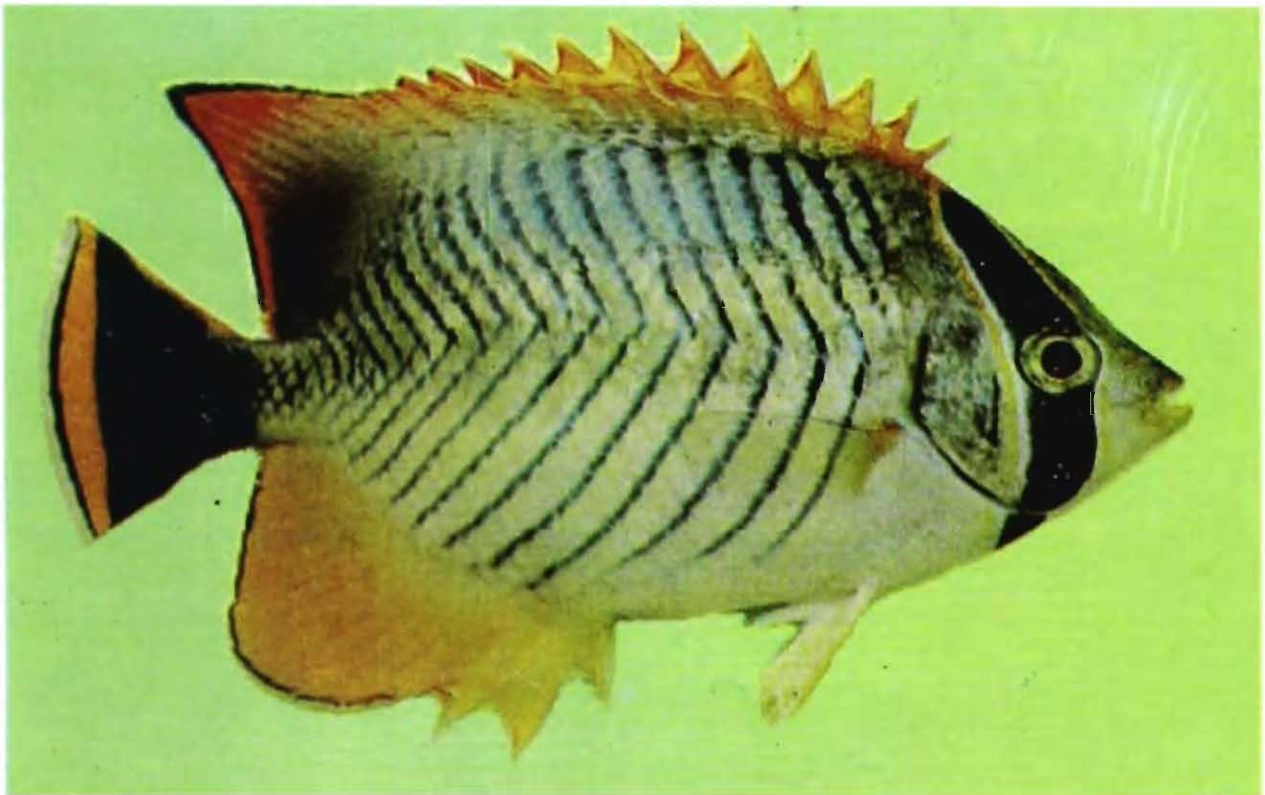


Fig. 21. *Chaetodon trifascialis*

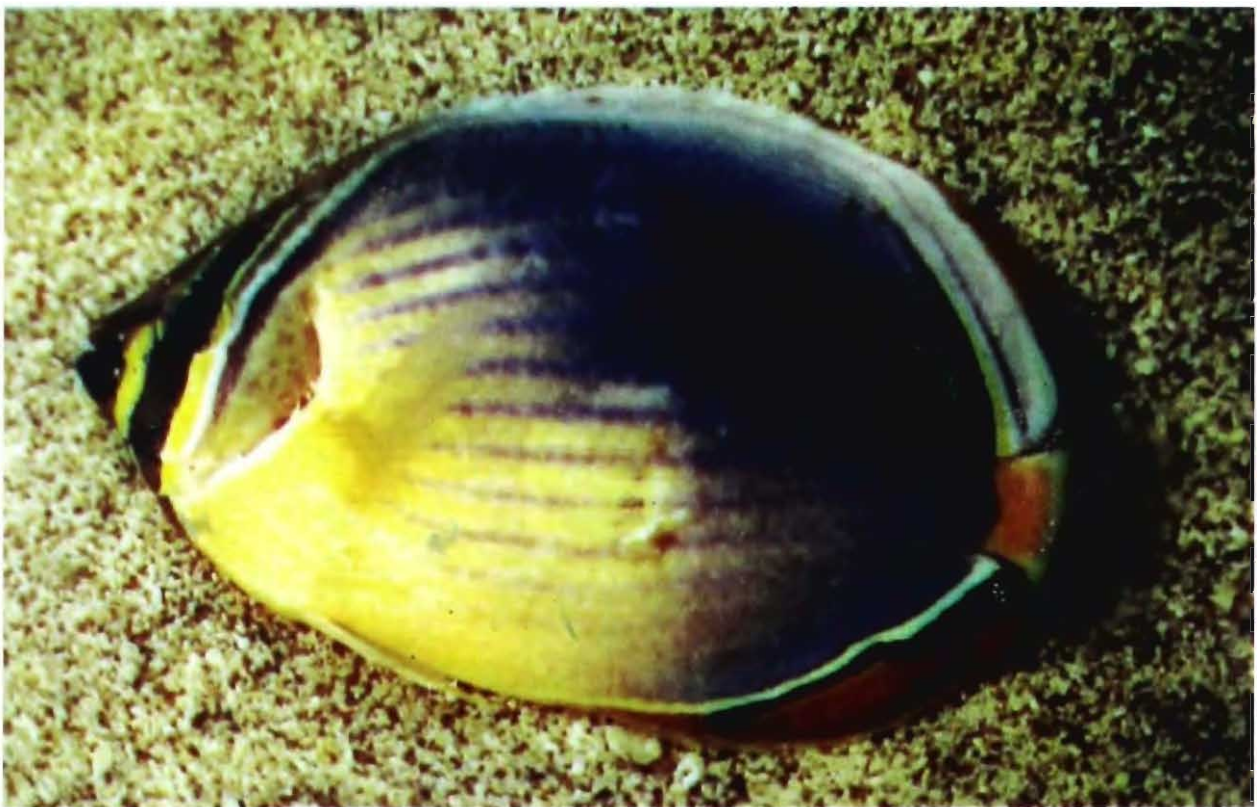


Fig. 22. *Chaetodon trifasciatus*

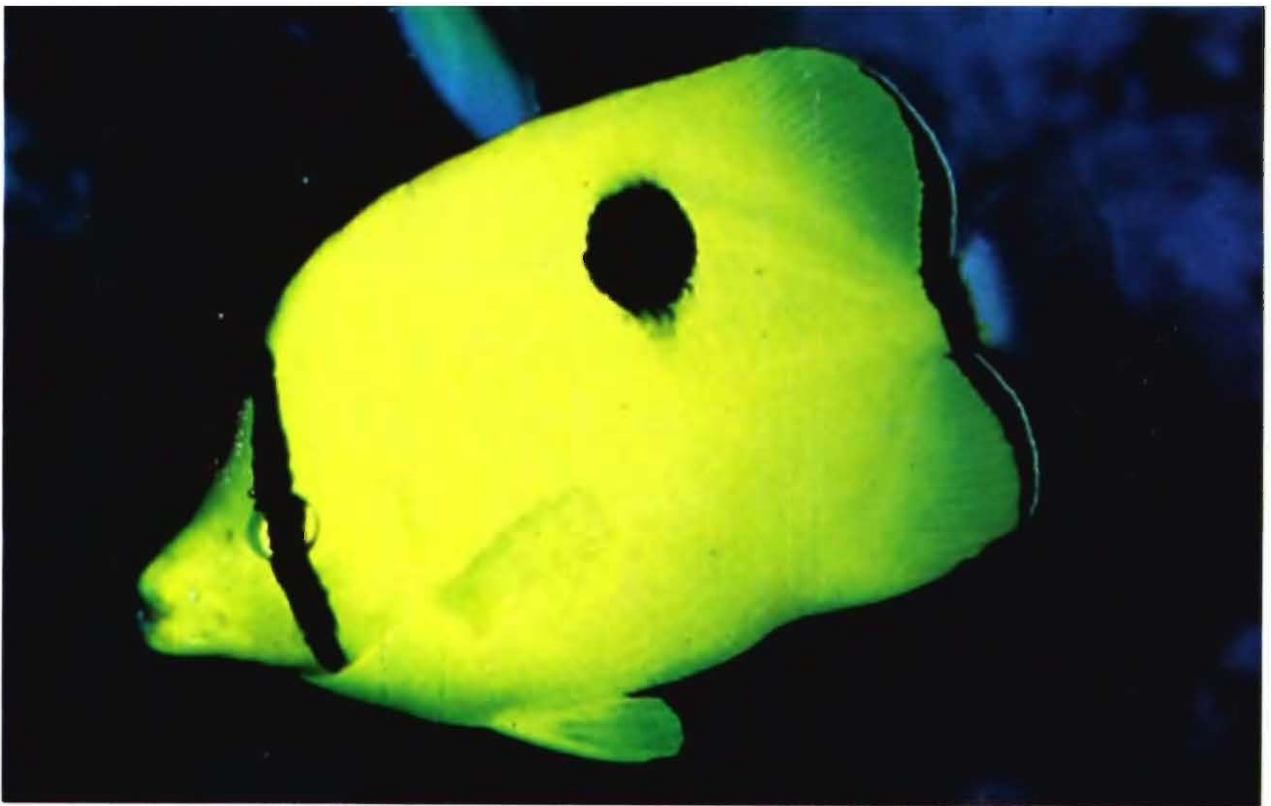


Fig. 23. *Chaetodon unimaculatus*

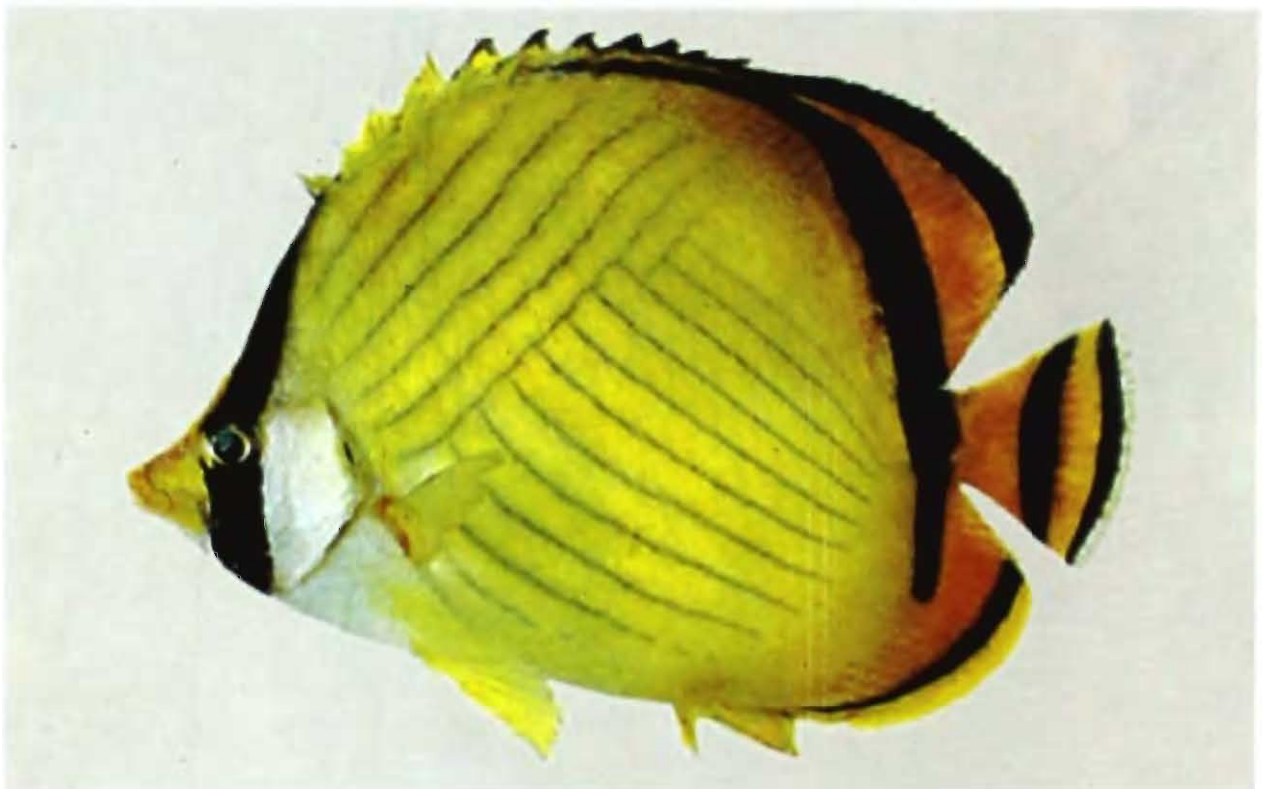


Fig. 24. *Chaetodon vagabundus*



Fig. 25. *Chaetodon xanthurus*



Fig. 26. *Chelmon rostratus*

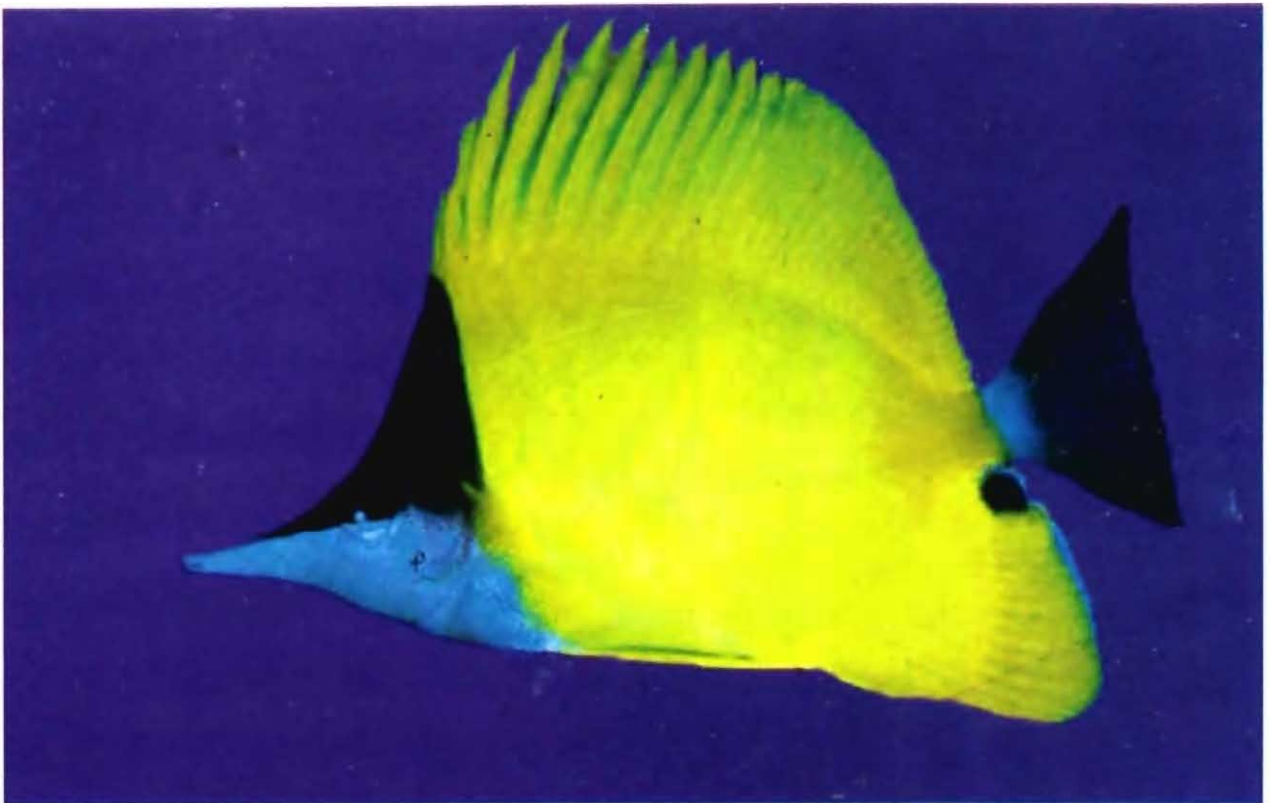


Fig. 27. *Forcipiger flavissimus*



Fig. 28. *Forcipiger longirostris*



Fig. 29. *Hemitaurichthys polylepis*

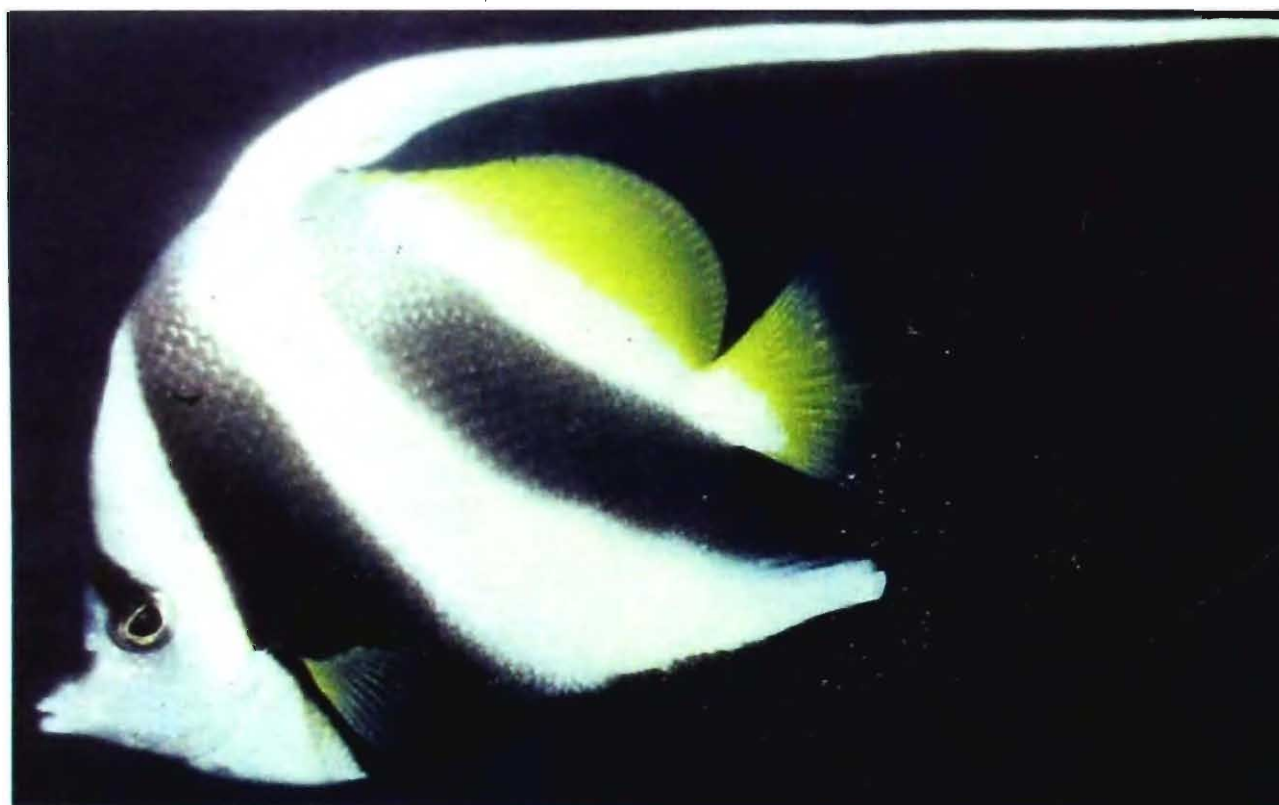


Fig. 30. *Heniochus acuminatus*

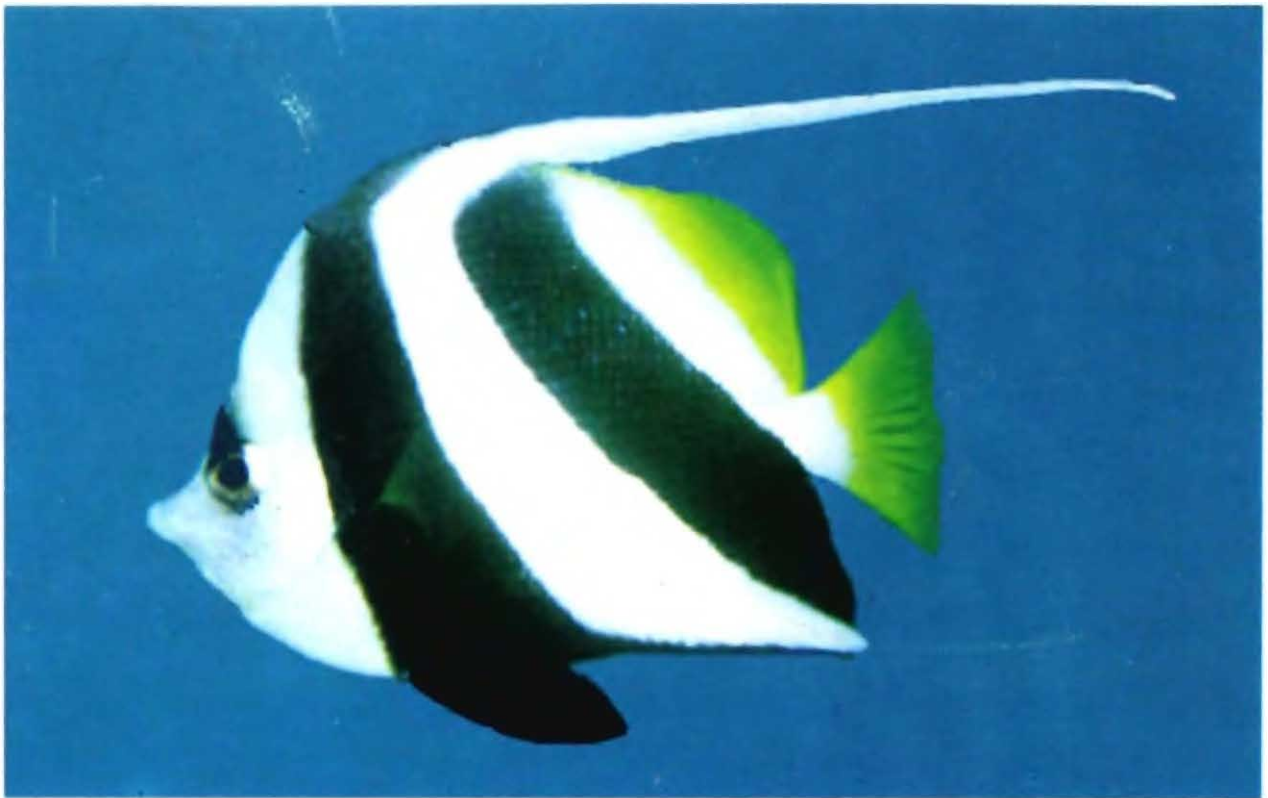


Fig. 31. *Heniochus diphreutes*

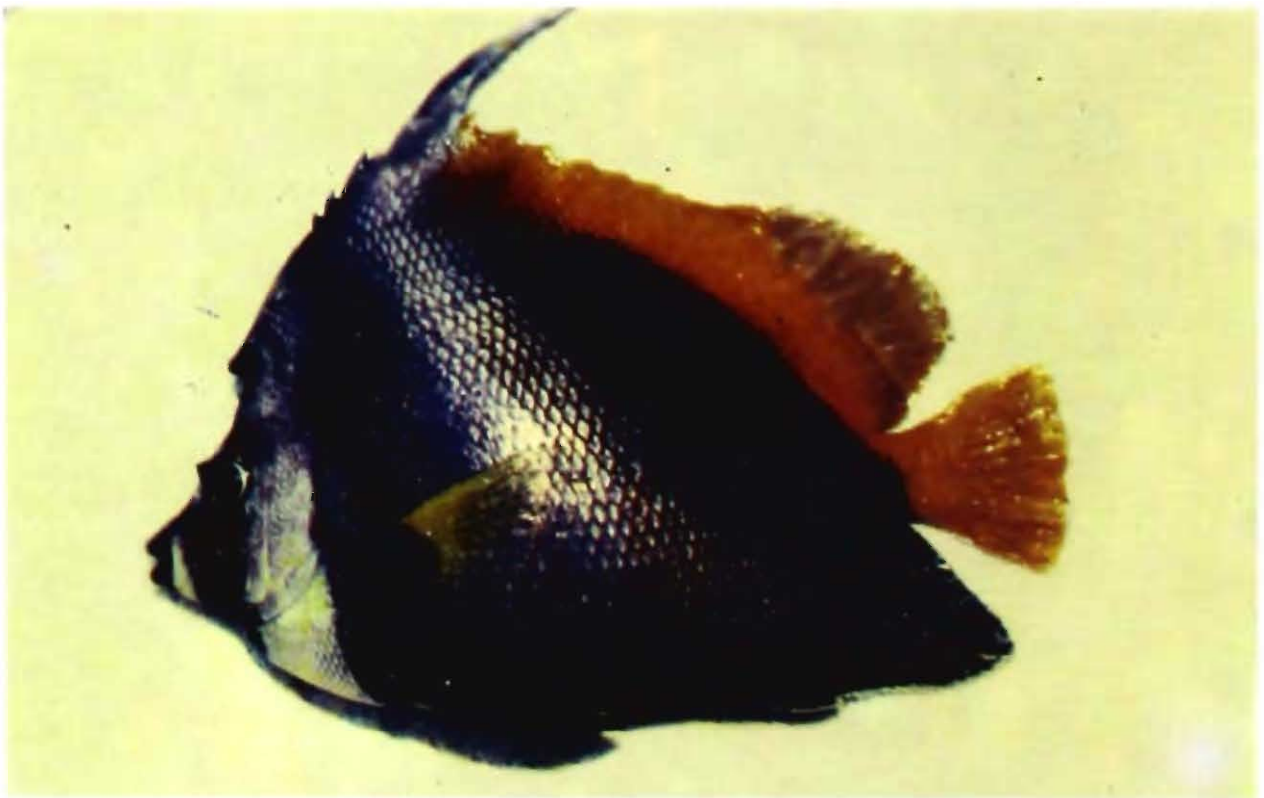


Fig. 32. *Heniochus singularius*



Fig. 33. *Heniochus varius*



Fig. 34. Sea Anemone- *Radianthus* sp.

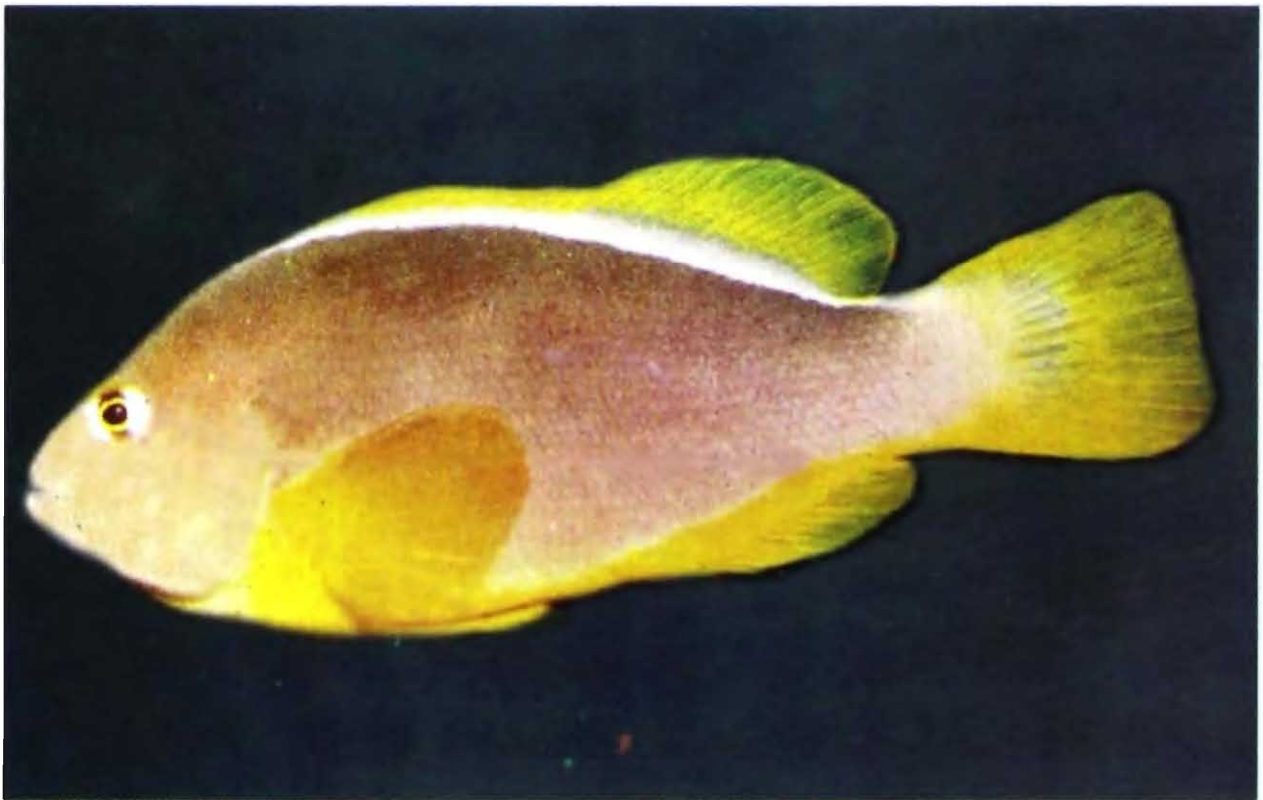


Fig. 35. *Amphiprion akallopisos*

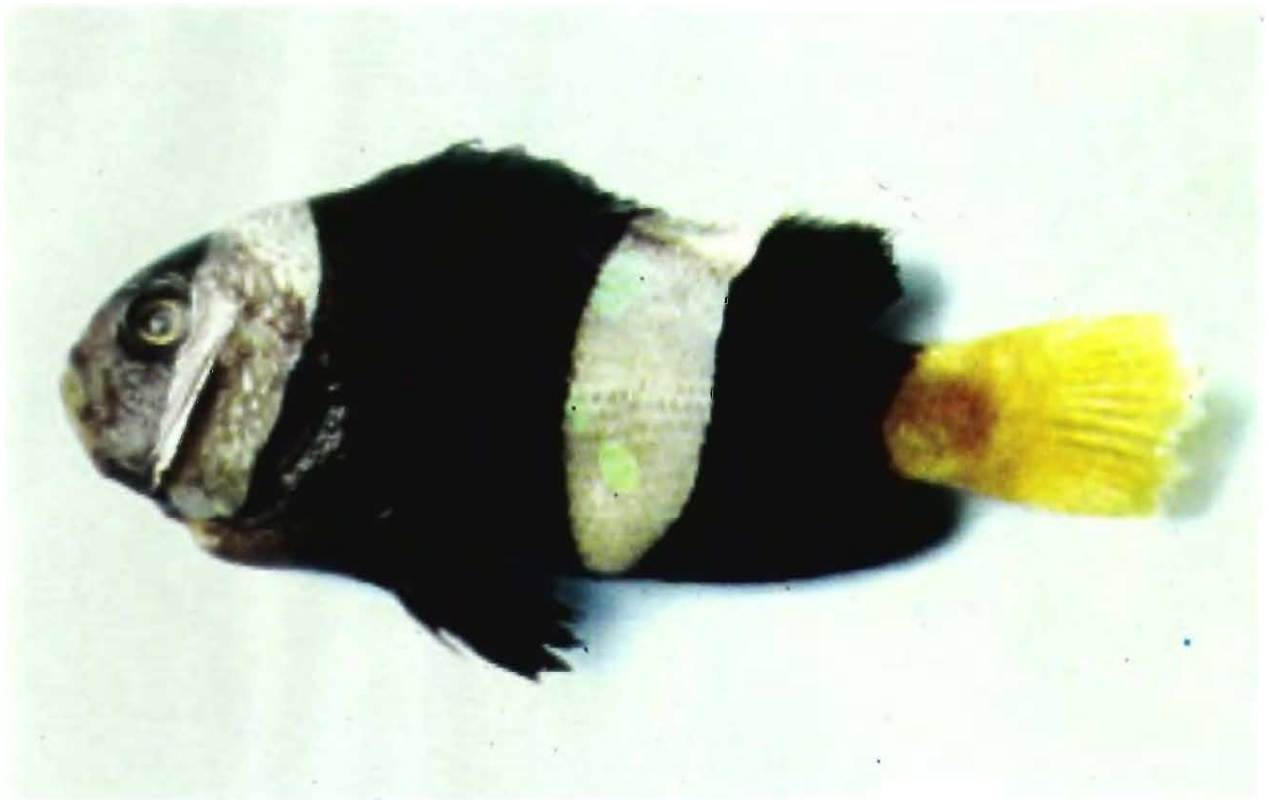


Fig. 36. *Amphiprion clarkii*



Fig. 37. *Amphiprion ephippium*



Fig. 38. *A. ephippium* on Sea anemone *Radianthus* sp.

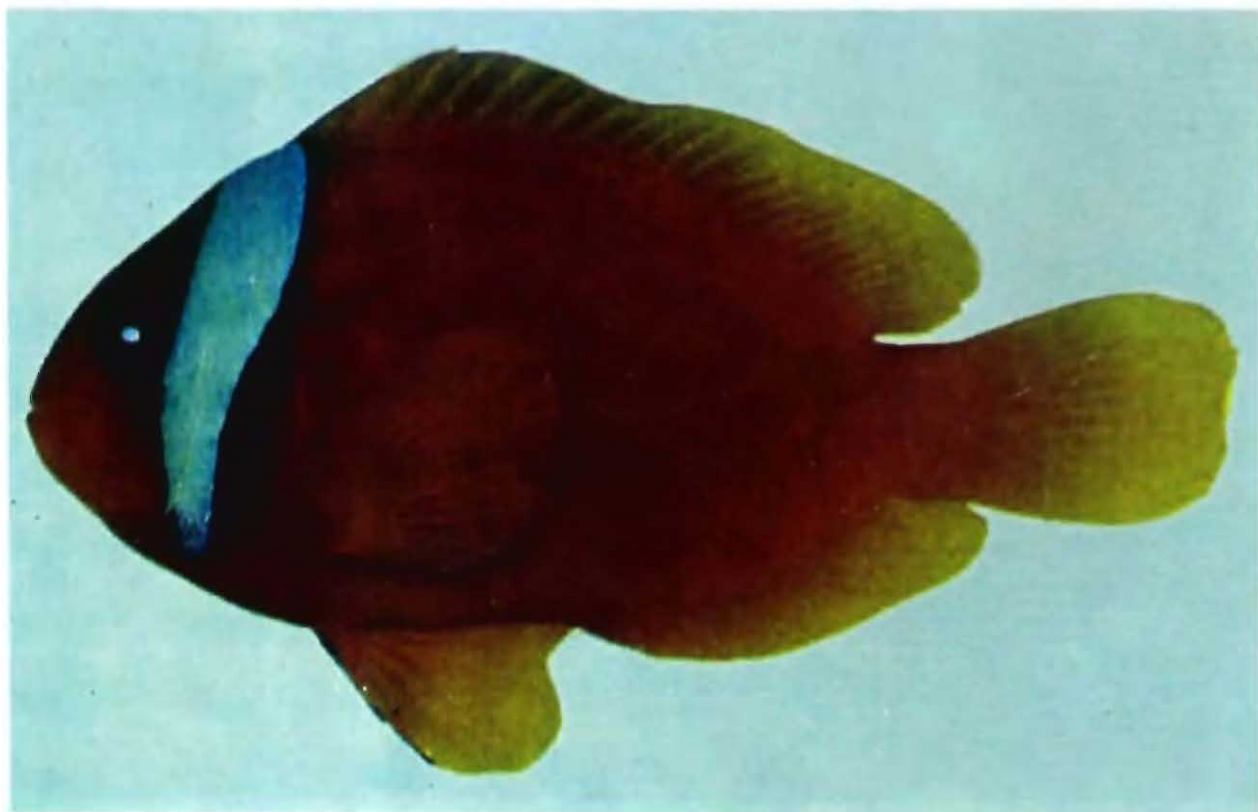


Fig. 39. *Amphiprion frenatus*



Fig. 40. *Amphiprion ocellaris*

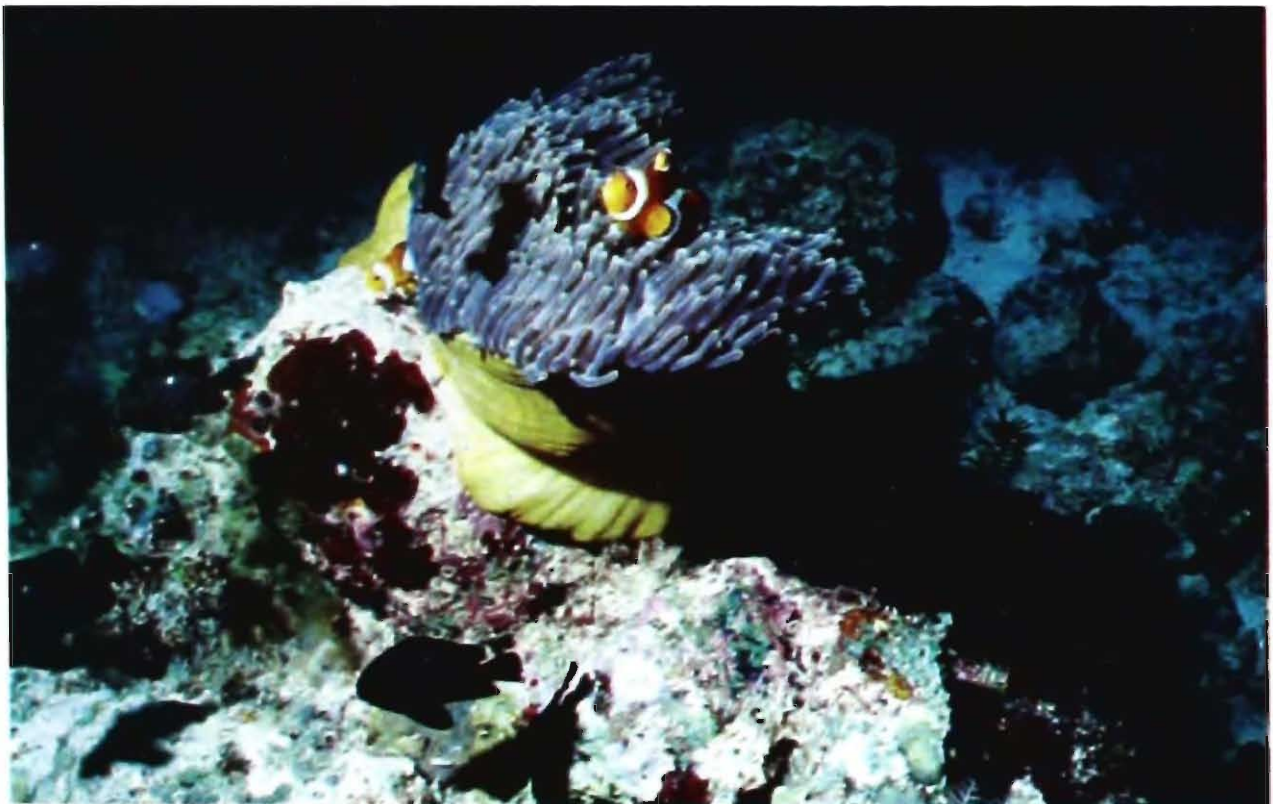


Fig. 41. *A. ocellaris* and *D. trimaculatus* with Sea anemone *Radianthus* sp.



Fig. 42. *Amphiprion peridarion*



Fig. 43. *Amphiprion polymnus*



Fig. 44. *Amphiprion sebae*

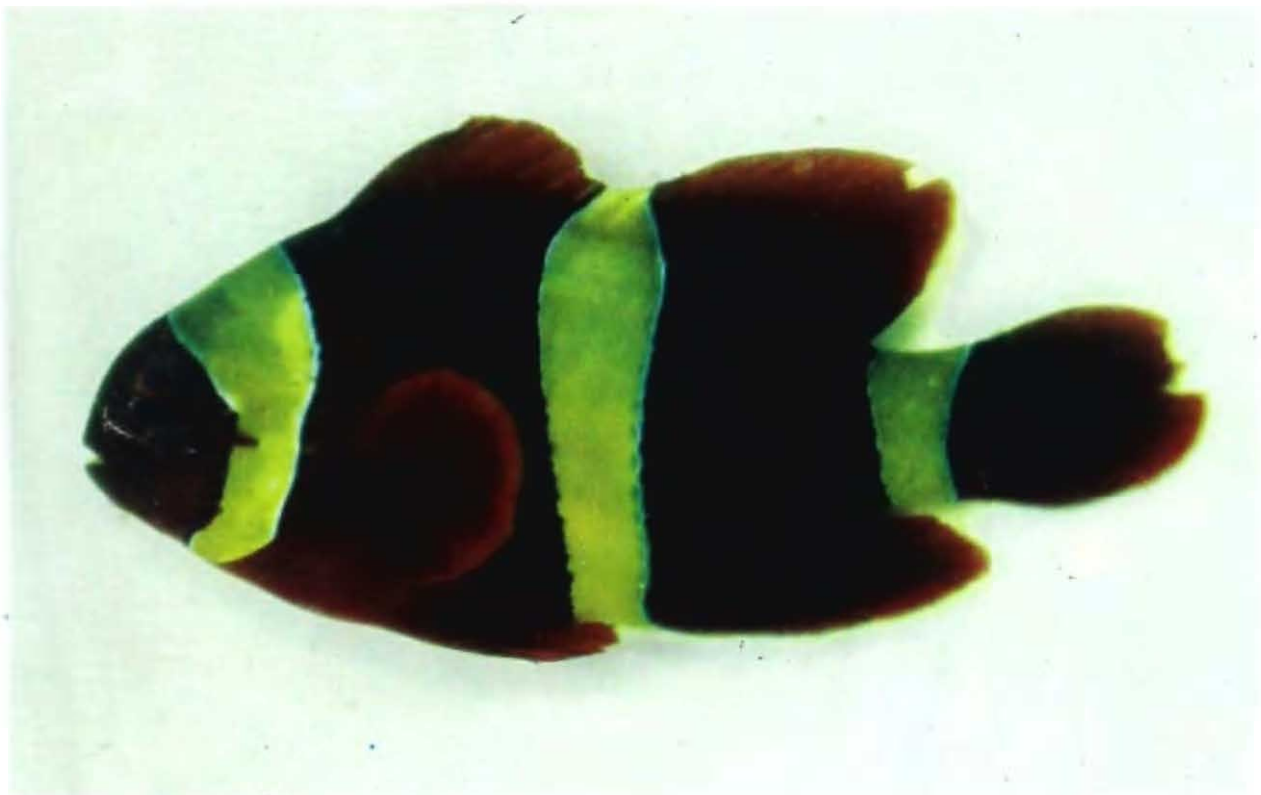


Fig. 45. *Premnas biaculeatus*



Fig. 46. *P. biaculeatus* on Sea Anemone



Fig. 47. *Dascyllus trimaculatus*

