

Biology of Some Important Demersal Fishery Resources

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Global total capture fishery production in 2014 was 93.4 million tonnes, of which 81.5 million tonnes from marine waters and 11.9 million tonnes from inland waters. Total capture production in marine waters was 81.5 million tonnes in 2014, a slight increase on the previous two years (SOFIA, 2016). The marine fish landings from the coast of the main land of India in 2017 was estimated as 3.83 million tonnes (t) showing an increase of 5.6% compared to in 2016. Landings in all the maritime states except Tamil Nadu increased in 2017. Highest landings was along the Gujarat coast (7.86 lakh t; 20.5%), followed by Tamil Nadu, Kerala and Karnataka with 6.55 lakh t (17.1%), 5.85 lakh t (15.3%) and 5.48 lakh t (14.3%). Percentage increase was high in Goa (64%), West Bengal (33%), Maharashtra (30%) and Kerala (12%). Along the Indian coast demersal finfishes form one of the major components in the marine fish landings. Demersal fish groups such as the sharks, groupers, snappers, threadfins, pomfrets and Indian halibut are commercially valuable and contribute substantially to the economy of Indian marine fisheries. Some of these groups, especially of large-size, are targeted by the fishermen by using different craft and gear combinations. However, several other demersal finfishes are not targeted, but are landed as bycatch by shrimp trawlers.

GROUPERS : This group is abundant in the rocky grounds off the South west coast and south east coast of India and is exploited by, hooks and lines, traps and gill nets. All India landings of perches is 4.27 lakh tonnes. Around 42 species of groupers have been reported from different parts of India. Family Serranidae includes *Epinephelus malabaricus* (Malabar grouper), *E. tauvina* (Greasy grouper), *E. bleekeri* (Dusky-tail grouper), *E. areolatus* (Areolate grouper), *E. diacanthus* (Spring cheek grouper/ six-banded reef cod), *E. epistictus* (Broken-line grouper), *E. fasciatus* (Red banded grouper), *E. flavocaeruleus* (Blue and yellow reef cod), *E. latifasciatus* (Banded grouper), *E. morrhu* (Banded cheek reef cod), *E. undulosus* (Brown-lined reef cod), *E. merra* (Wire netting reef cod), *E. fusco guttatus* (Brown marbled grouper), *E. chlorostigma* (Brown spotted grouper), *Cephalopholis sonnerati* (Red coral cod) and *C. boenack* (Blue-lined seabass).

Groupers have long lifespans, are slow growing, relatively large in size, and have a low natural mortality rate. The larger species form breeding aggregations, and most species are protogynous hermaphrodites. Among the Epinephelinae, monandry protogynous hermaphroditism is the most common sexual pattern [Shapiro, 1987]. A few species, such as the *Epinephelus coioides* and the *Epinephelus andersoni*, are diandry, where the males can either develop from the females or they can develop directly from the juvenile phase [Sadovy and Shapiro, 1987; Fennessy and Sadovy, 2002]. The latter sexual pattern suggests that some females do not change sex at all, and some males do not pass through female stages at all. Their aggressive nature and relatively large size makes them more vulnerable to fishing gears (Munro and Williams, 1985). They are generally long-lived and slow growing with low rates of natural mortality (Ferreira and Russ, 1994; Grandcourt, 2005), form spawning aggregations (Domeier and Colin, 1997) and this predisposes them to

overexploitation. Furthermore, aspects of their reproductive biology, such as female biased sex ratios and the potential for the differential removal of larger older males make them particularly vulnerable to the effects of fishing (Sadovy, 1996). Protogynous species are said to be far more vulnerable to fishing pressure than comparable gonochoristic stocks (Huntsman and Schaaf, 1994). For protogynous species, in which males tend to be larger than females on average, size-selective fishing mortality (gillnetting/hooks is used for fishing) may result in the loss of larger older males (as reported by Sadovy, 1996), which may result in the possibility that insufficient males remain in the reproductive population to fertilize eggs from all females (Koenig et al., 1993). Marine protected areas (or no-take zones) are considered a valuable management alternative for protecting the size and age structures as well as the breeding populations of coral reef fishes.

Epinephelus coioides is found along the coastlines of continents and large islands to a depth of 100m where it inhabits coastal reefs and is often found in brackish water in association with mud and rubble substrates (Lieske and Myers, 1994). Juveniles are common in the shallow waters of estuaries, over sand, mud and gravel and among mangroves (Kailola et al., 1993; Sheaves, 1995). The diet consists of fishes, shrimps, crabs and other benthic crustaceans. It is a large, relatively long-lived species attaining 111.0 cm total length and 15.0 kg in total weight with a maximum age of 22 years (Mathews and Samuel, 1991; Heemstra, 1995). As with many of the Epinepheline groupers, *E. coioides* is a protogynous hermaphrodite, undergoing female to male sex change (Quinitio et al., 1997).

Epinephelus areolatus: The areolate grouper *Epinephelus areolatus* is a coral reef fish that is widespread in the Indo-Pacific region but has been recorded nearly worldwide, including in the Red Sea, Persian Gulf, South Africa, Japan, the Arafura Sea (Russell and Houston, 1989). In the Arabian Gulf it reportedly has a prolonged spawning season that extends from June to September for females and to August for males. *E. areolatus* reached sexual maturity at 24.3 cm for males and 25.5 cm for females, which correspond to 2.04 years and 2.23 years, respectively. Fishing of spawning aggregations leads to a reduction in the average size of the individuals caught and a remarkable decline in the M:F sex ratio since this is a protogynous species.

E. diacanthus: The ovary is of the cyst-ovarian type into which matured eggs will be released during ovulation; the ova will pass through oviduct on their way to go out at the genital pore. The genital pore is a smaller pore behind the anus; which becomes pinkish during spawning season. The wall of the gonad is covered externally with a peritoneal layer.

Stages of the ovary

Stage I –immature I - relatively small, translucent and white pinkish in colour.

Stage II - Mature resting female / maturing female stage II of larger than Stage I and white brownish in colour.

Stage III - is defined as the ovarian stage in which active vitellogenesis taking place in preparation for spawning in the mature active female/ripe female. The ovary occupies 2/3rd of the body cavity and is light yellowish in colour..

Stage IV –Ovary occupies the gonad cavity –is pinkish in colour and is ready for spawning. Gonad weight is also increased.

Stage V –Spent –Gonads are flaccid –loose and shrunken –covered with blood shots and veins

Species in Indian waters

Some common species

Aethaloperca rogae (Forsskal, 1775)

Redmouth grouper

D IX, 17; A III, 8; P 17-18; V I, 5.

Body rounded its depth greater than head length; mouth slightly superior; dorsal profile of head steeply sloped; small hump on nape; pre-operculum finely

serrated; operculum with 3 undeveloped spines; pelvic fins equal to pectorals, reaching the level of anus or beyond; caudal fin truncate.

Body uniformly dark brown to black; reddish inside the mouth, gill cavity and upper jaw membrane; soft-rayed part of dorsal fin and caudal fin margin white.



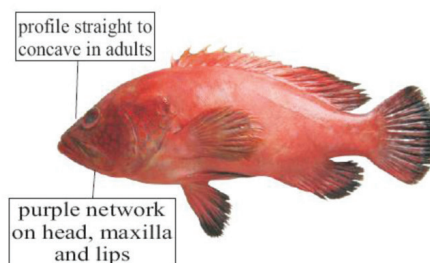
Cephalopholis sonnerati (Valenciennes, 1828)

Tomato hind

D IX, 15; A III, 9; P 17-18; V I, 5; Gr 14 to 16.

Body depth, greater than or equal to head length; dorsal profile of head near eye and nape strongly convex; mouth small, slightly superior; maxilla reaches posterior of eye; pre-operculum rounded; **operculum spines**

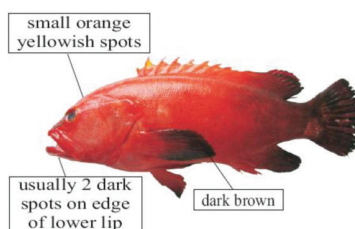
very small, poorly developed; Body bright orange to red, with scattered bluish-white



spots; head purplish to red with numerous close-set orange-red spots; opercular flaps dark reddish; all fins reddish, the membranes of soft dorsal, caudal, anal, pectoral and pelvic fins dark red to dusky.

Cephalopholis urodeta

Similar to *C. sonnerati*, but differs in the absence of the reticulate pattern in *C. sonnerati*



***Epinephelus polyphkadion* (Bleeker 1849)**

Camouflage grouper

D XI, 15; A III, 8; P 16; V I, 5; LL 47 to 52; Gr (8-10) + (15-17).

Dorsal profile of head evenly convex; maxilla reaches rear edge of eye; pre operculum rounded, the serrae at corner slightly enlarged; two undeveloped spines in operculum; inter spinous membranes moderately incised; caudal fin rounded; body scales ctenoid.

Body pale brownish covered with numerous small dark brown spots; some irregular dark blotches



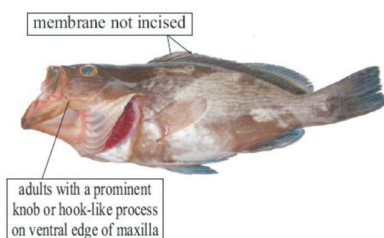
superimposed with the spots scattered in head and body; **a prominent black blotch on caudal peduncle**; dark spots extend all over head, including lower jaw, lips and inside of mouth; numerous small white spots on fins and a few on head and body.

***Epinephelus undulosus* (Quoy & Gaimard 1824)**

Wavy-lined grouper

D XI, 20; A III, 8; P 18; V I, 5; LL 70 to 75.

Eyes small; mouth superior to slightly protractile; pre-operculum highly serrated at the



angle; operculum notched with 2 undeveloped spines; **dorsal fin membrane not notched** between the spines; body scales ctenoid, except on belly; caudal fin truncate to slightly concave. Body generally brownish to purplish grey, usually with golden brown

to yellowish spots on head and upper body, which becomes wavy longitudinal lines in mid body; median fins and pelvic fin black to brown in base and bluish in the tip; preserved specimen becomes brownish with dark spots and lines.

***Epinephelus longispinis* (Kner 1864)**

Longspine grouper

D XI, 16; A III, 8; P 18; V I, 5; LL 49 to 53; Gr (8 to 11) + (15 to 17).

Body deep, upper edge of operculum straight or slightly convex, with 3 undeveloped spines; the third or fourth spine longest, its length contained 2.1 to 2.6 times in head length; caudal fin rounded, convex.

Body pale to brownish and grey laterally; reddish to dark brown spots all over the body, which is round in head and slightly elongated in sides; some dark



spots or blotches at dorsal fin base; median and paired fins with dark brown spots; tip of the fins slightly yellowish; preserved specimen becomes brownish with dark spots.

***Plectropomus leopardus* (Lacepede 1802)**

Leopard coral grouper

D VII, 12; A III, 8; P 16; V I, 5; LL 89 to 99; Gr (1-3) + (6-10).

Body elongate, robust; Head comparatively small, 2.7 to 3.1 times in standard length;

dorsal profile of the head slightly sloped, with a concave insertion near nape; eyes slightly prominent; mouth oblique, slightly superior; preoperculum rounded,



with 3 large, spines along lower half; operculum with 3 flat spines, the upper and lower spines covered by skin; pectoral fins subequal to pelvic fins; caudal peduncle broad; caudal fin emarginated.

Body brownish to orange-red, with numerous small dark-edged, blue spots on head and body (except ventrally) and fins; spots slightly elongated near mid body; pectoral fins reddish with darker rays; a indistinct dark band at rear margin of caudal fin.

***Variola albigarginata* (Baissac 1953)**

White-edged lyretail

D IX, 14; A III, 8; P 18; V I, 5; LL 120-130; Gr (7-9) + (13-16).

Body elongated, moderately deep; dorsal profile of head gently sloped; eyes small; mouth oblique, terminal; jaws with sharp canine teeth; maxilla reaches beyond the eye; pre-operculum finely serrate; operculum spines not well developed; soft rays tips of fins slightly elongated; caudal fin crescentic, the upper and lower rays elongate.



Brownish orange to reddish with numerous irregular, small whitish to pink or lavender spots to streaks; fins colour same as body except pectoral fin and caudal fin rear margin; rear margin of caudal fin dusky with a narrow white edge; pectorals yellowish; preserved specimens changes complete brownish white.

***Epinephelus coeruleopunctatus* (Bloch, 1790)**

White Spotted grouper

D XI, 15; A III, 8; P 18; V I, 5; LL 52-62; Gr 10+14-17.



Body moderately elongated; dorsal profile of the head nearly straight; head pointed; Body depth more or less equal to head length; pre-operculum rounded, serrated; eyes big, prominent; dorsal and anal fin soft rays, pectoral and caudal fins

rounded.

Body brownish gray to black with numerous large white spots including fins; dark blotches below dorsal fin and caudal peduncle; prominent black streak on maxillary groove.

***Cephalophalis miniata* (Forsskål, 1775)**

Coral hind

D XI, 14; A III, 8; P 17; V I, 5; LL 47-56; Gr 7-9+14-16.

Body moderately deep; dorsal profile of the head straight, with convex above eye; maxilla big, crossing the rear edge of eye; eyes small; pre-operculum rounded; soft rays of dorsal and anal fin, pectoral and caudal fins rounded.



Body orange to reddish brown, with small blue spots all over the body including fins; Margin of soft rays of dorsal and anal and caudal fins bluish.

***Anyperodon leucogrammicus* (Valenciennes, 1828)**

Slender grouper

D XI, 14; A III, 8; P 15; V I, 5; LL 61-72; Gr 7-9+14-17.

Body elongated, slightly compressed; head elongated, its length greater than body depth; dorsal profile of the head slightly sloped to straight; eyes moderate; mouth



large terminal; pre-operculum slightly serrated, rounded; interfin membrane of soft rays transparent; soft rays of dorsal and anal fin, pectoral and caudal fins rounded.

Body greenish brown to gray with numerous reddish spots including head and fins; spots in head small; 3 to 4 longitudinal white bands running from mouth to caudal peduncle.

***Cephalopholis argus* (Schneider, 1801)**

Peacock hind

D XI, 16; A III, 9; P 16; V I, 5; LL 46-51; Gr 9-11+17-19.

Body deep; head big, its length 2.4 to 2.7 times in standard length; eyes small; mouth big, terminal to slightly superior; maxilla extends beyond to the level of eye; pectoral fin fleshy; dorsal and anal fin soft rays, pectoral and caudal fins rounded.



Body dark brown with numerous blue to white spots with dark margin; 5 to 6 pale vertical bars on the rear part of body; dorsal fin spines with orange margin; posterior margin of median fins darker with a narrow white tip; pectoral fin with dark brownish to purplish red posterior edge.

***Cephalopholis formosa* (Shaw, 1812)**

Bluelined Hind

D IX, 18; A III, 8; P 15; V I, 5; LL 47-51; Gr 6+15.

Body moderately, deep; dorsal profile of the head sloped with convex inter-orbital; eyes small; maxilla ends at



posterior end of the eye; dorsal and anal fin soft rays, pectoral and caudal fins rounded; body scales ctenoid.

Body dark yellowish brown, fins darker; wavy longitudinal blue lines all over body including head and fins; blue spots on the snout, lower part of head and thorax.

***Epinephelus lanceolatus* (Bloch 1790)**

Giant grouper

D XI, 14; A III, 8; P 16; V I, 5; LL 46-51; Gr (9-11)+(17-19).

Body robust in adult and slightly deep in juveniles; dorsal profile of the head slightly convex; eyes small; mouth moderately big, terminal to superior; maxilla reaching rear edge of eye; pre-operculum finely serrated in edges; inter fin membrane of spines



notched; soft rays of dorsal and anal fin, pectoral and caudal fins rounded.

Body greyish yellow above, grayish white below and sides with numerous

uneven black blotches all over the body; head darker; fins yellowish with black blotches; juveniles with 3 irregular black bars in body, large adults dark brown to grey. This is a protected species under Wild Life (Protection) act, 1972 of India.

***Cephalopholis cyanostigma* (Valenciennes, 1828)**

Blue spotted hind

D IX, 15; A III, 8; P 15; V I, 5; LL 46 to 50; Gr 7-9+14-18

Body moderately compressed, deep; dorsal profile of head convex above eye; eyes small slightly projected; mouth large terminal to superior; maxilla vertically reaching the rear edge of the eye; pre-operculum rounded; body scales ctenoid; soft rays of the dorsal and anal fin, pectoral and caudal fin rounded.



Body brown to brownish red, head darker; with numerous black edged bluish spots all over the body

including fins; spots in head, chest and belly comparatively big with spots in fins and posterior body; sides with 4 to 5 dark chain like bars; median fins darker than body colour; pectoral fin darker or with black margin at the free tip.

***Epinephelus ongus* (Bloch, 1790)**

White streaked grouper

D XI, 14; A III, 8; P 15; V I, 5; LL 48 to 53; Gr 8-10+15-18.

Body comparatively deep; dorsal profile of head steeply sloped, slightly convex above eye; eyes big projected; mouth moderately small; maxilla vertically reaching middle of the eye; head slightly pointed; pre operculum rounded; soft rays of dorsal and anal fins, pectoral and caudal fin rounded.



Body brownish with numerous small white spots all over the body which sometimes forms wavy lines; head

darker with less white spots; median fins with small white spots, posterior margin darker with white tip; paired fins greyish brown.

***Epinephelus merra* (Bloch, 1793)**

Honeycomb grouper

D XI, 17; A III, 8; P 17; V I, 5.

Body robust, slightly compressed, elongated; mouth superior, large, maxilla exposed, slightly protractile; small, slender teeth on jaws, vomer and palatine; some small canines on front; eyes prominent; dorsal profile of the head sloped; pre-operculum serrated; one flat spine on operculum; small ctenoid scales; pectoral fin like an hand fan; caudal fin rounded.



Body grey above and lighter below; brown to black spots all over the body, hexagonal anteriorly, rounded posterior; fins rays of dorsal and caudal fin yellowish; pectoral and pelvic fins dark brown to black.

***Epinephelus flavocaeruleus* (Lacepède, 1802)**

Blue-and-yellow grouper

D XI, 8; A III, 5; P 16; V I, 5; LL 61-74; GR (9-10) + (15-17)

Body deep; dorsal profile convex; eyes small, head length 2.5 in SL; BD 2.5 in SL; nostril top of the eye; mouth inferior;



teeth canine; operculum with undeveloped spines; pre-operculum serrated; interfin membrane of dorsal fin deeply notched; caudal fin truncate; caudal peduncle thick and short. In fresh condition body colour blackish with bright yellow dorsal, anal and caudal fins; outer tip of caudal blackish; in formalin preserved specimens fins are whitish; black tip of caudal fin is retained.

***Epinephelus spilotoceps* (Schultz, 1953)**

Four saddle grouper

D XI,17;A III,8;P 17;I,5;LL 60-69;GR (7-8)+(15-18)

Body elongated; pre dorsal profile is slightly convex; eyes small; head length 2.5 in SL; BD 2.5 in SL; mouth inferior; maxillary ends at the middle of the eye; teeth canine;



operculum with one developed spine; pre-operculum serrated; pectoral fin origin in front of the pelvic fins; dorsal fin spinous interfin membrane deeply notched; caudal fin truncate; caudal peduncle thick and short.

In fresh condition the body colour is yellowish brown with spot all over the body; in formalin preserved specimens the black spots are light black.

***Epinephelus diacanthus* (Valenciennes, 1828)**

Thornycheek grouper

D XI, 15-17; A III, 8-9; P 18-20; VI, 5; LI 105-120.

Body depth contained 2.8 to 3.2 times in standard length. Pre-opercle border forming nearly a right angle, with 1 to 3 enlarged serrae at the angle; sides of lower jaw with 2 rows of small subequal teeth; anterior nostrils tubular, with a large flap posteriorly extending over rear nostril; lower gillrakers 14 to 16. caudal fin rounded to almost truncate. Pored lateral line scales 53 to 60. Body generally buff, with 5 more or less distinct, vertical dark bars; 4 bars below dorsal fin and 5th on caudal peduncle. Ventral part of head and body reddish. Some specimens with a black streak across cheek at upper edge of maxilla. Dark bars on body sometimes absent.



***Epinephelus malabaricus* (Schneider, 1801)**

Malabar grouper

D XI, 14-16; A III, 8; P 18-20; VI, 5; LI 98-114.

Body depth contained 3.0 to 3.6 times in standard length. Pre-opercle finely serrate, with a shallow notch, the serrae enlarged at the angle; rear nostrils not more than



twice the size of anterior nostrils; lower gillrakers 13 to 16; mid lateral part of lower jaw with 2 rows of teeth. Midlateral body scales distinctly ctenoid with minute auxiliary scales.

Head and body generally pale greyish brown covered with small orange, golden brown, or dark brown spots. Five more or less distinct, slightly oblique, irregular, broad, dark bars on body; these bars are darker dorsally and the last 3 are usually bifurcate ventrally; the first 4 bars usually continued onto the dorsal fin, the last bar covers most of the caudal peduncle; usually 3 dark blotches on interopercle, the first 2 sometimes merging to one blotch; small, irregularly shaped and spaced, white spots visible on head and body of some fish; soft dorsal, caudal, anal and pectoral fins brownish-black with small dark spots on basal half of fins.

Reproductive Biology Stages:

Threadlike : Sex cannot be determined at this maturity stage, and the gonads in individuals appear as filaments occupying a small portion of the body cavity

Stage I (Immature or inactive): The gonads have a translucent appearance, and testes are smaller and thinner than ovaries.

Stage II (Spent recovery with colour): The gonads are translucent and enlarged. The testes do not contain sperm, while the ovaries possess a few small eggs.

Stage III (Developing): Gonads are larger, and testes are opaque without sperm. Ovaries are translucent with small eggs. Extend upto $\frac{3}{4}$ of gut

Stage IV (Ripe or Fully developed): Testes are white, sperm is expelled from the core when cut. Ovaries are not translucent but opaque and solid with fully formed eggs.

Stage V (Spawning): Gonads are enlarged, and occupy most of the body cavity. Milt and eggs are expelled from the genital openings on application of slight pressure to the two sides of the genital tract.

Stage VI (Spent): Ovaries are flaccid with few degenerating eggs in the ovary, while the testes are almost empty.

Gonado somatic index –GSI -.

Gonadosomatic indexes (GSI) were calculated as $GSI = (GW / (TW - GW)) \times 100$, where GW= gonad weight (g) and TW=total fish weight (g). The state of maturity of a fish may be determined by the size of ovaries. Gonado-somatic index (GSI) indicates the stage and readiness of the ovary for maturation and spawning. Throughout maturation, the GSI values of females were much higher than males implying a greater proportion in body reserves were allocated to the gonads. Gonadosomatic index has been used by many earlier investigators like Htun-Han (1978) to explain the degree of ripeness of ovary in a number of fishes.

Hepatosomatic indexes (HIS) were calculated as $HIS = (LW / TW) \times 100$, where LW= liver weight (g) and TW= total fish weight (g).

The condition factor (K) is a measure of fish energy reserves. Condition factor values follow interannual

variations and seasonal cycles (Lambert and Dutil, 1997) Fulton's condition factor is calculated using the equation: $KF = 100 \times (W / L^3)$

The **length-weight relationship** calculated using the expression: $W = aL^b$

where, W is the body weight (g) and L is the total length (cm).

Parameters a and b can be estimated by linear regression analysis based on natural logarithms:

$$\ln(W) = \ln(a) + b \ln(L)$$

Additionally, 95% confidence limits of b and the coefficient of determination r^2 were estimated. In order to confirm whether b values obtained in the linear regressions were significantly different from the isometric value ($b = 3$), a t-test can be applied,

Fecundity – The number of eggs produced per female per unit time (e.g., per spawning season). Fecundity has been considered as the number of ripening eggs in the female prior to spawning. Fecundity of the fish is the most important aspects of the reproductive biology of the fish which must be understood to explain the variation in the level of production as well as to make efforts to increase the amount of harvest. Alternatively fecundity may be expressed per unit body weight of post stripes fish when it is known as relative fecundity because the number of eggs produced for each unit increase in weight shows significant linear variation

Fecundity is calculated by the following formula: $F = n \times G / g$

where, F is fecundity, n is the average number of eggs in sub-sample, G is weight of the gonads and g is the weight of the sub-sample.