III.4. COMMERCIAL FISHING GEARS AND METHODS USED IN HELLAS

A. Adamidou

Fisheries Research Institute,
NAGREF,
64007, Nea Peramos,
Kavala, Hellas

adamidou@inale.gr

INTRODUCTION

Since humans began fishing at least 90 000 years ago, fishing technology has evolved from simple harpoons and hooks to industrial factory trawlers in the 20th century (KENNELLY & BROADHURST, 2002). The first known use of fishing gears by humans is reported by YELLEN *et al.*, (1995) and refers to the use of harpoons to catch catfish. The use of hand lines, nets and fish pots is mentioned in the scripts of many 'classical' writers (e.g. Aristotle, Homer, Oppianos). The use of an early type of beam trawl in the river Thames in the 14th century and the discards that were produced caused the first attempt to enforce regulations for the operation of a fishing gear (DYSON, 1977). The introduction of more active fishing methods like the use of purse seines in the USA in 1826, the invention of a Danish seine in 1848 and the first use of modern otter trawls in England and Ireland around 1860, indicate the rapid progress in fishing gear technology as well as the commercialization of the fisheries.

The purpose of this chapter is to describe briefly but as clearly as possible the main types of commercial fishing gears and methods currently in use in Hellenic marine fisheries. The chapter includes both the gears used in coastal fisheries and open sea fisheries. The classification and terminology followed is according to the FAO Fishing Gear Classification (NEDELEC & PRADO, 1990). The way that the gears operate and their demands on the operating vessel are also considered (SAINSBURY, 1996). So, they are cited as follows:

- Towed and dragged gears (bottom trawl, boat seine, dredges)
- Encircling gears (day and night purse seine, small surrounding net)
- Static gears (nets, long lines, pots)

The technical characteristics, according to official records of the gears throughout Hellas (FILLIPOUSIS *et al.,* 1989, 1991; ANASTASIADOU *et al.,* 1990, 1992; KARLOU *et al.,* 2006), the way of operation and the target species are reported for each gear. However, all the gears mentioned occur in great variety in Hellenic ports determined by the local conditions, thus the more representative types are described herein. The legislative provisions concerning the different gear types are provided in Chapter III. 7 (Management and legislation in Hellenic fisheries).

TOWED AND DRAGGED GEARS

Bottom trawl

The traditional bottom trawl gear used in Hellas is a low opening gear that consists of many rectangular pieces of netting connected side by side, with numerous selvages, forming a big funnel-type net. The netting is made of multifilament twine, knotted and knotless, with diamond meshes. This type of trawl gear is relatively the same irrespective of the species that is mainly targeted each time. Minor modifications that are made to the gear by the fishermen, are usually associated with the fishing grounds or other local demands and do not significantly change the main structure of the gear. The main sections of the Hellenic bottom trawl gear are the wings, the main trawl body or shoulders, the extension piece and the cod-end (Figure 1).

Wings are made of two half sections that consist of 1-4 pieces of net each, are about 11-12 m long and the netting stretched mesh size is mainly 90 mm. The main body comprises of an equal number (usually 4-6) of rectangular pieces of netting, each 100 meshes wide, placed at the right and left side of the central triangle located at the upper (tselo) and lower (boukos) part of the trawl body, respectively. The length of the main body is about 20 m and the netting stretched mesh size ranges from 40 to 70 mm. The extension piece consists of 5-7 pieces of net of 100 meshes wide each. It is about 19 m long and the netting stretched mesh size is mostly 40 mm. The last part of the net, the cod-end, consists of 1-6 pieces of net. The cod-end is about 7 m long, its overall width is mostly 300 meshes, which is the same lengthwise, and the netting stretched mesh size is 40 mm. It is usually covered by a strengthening piece of netting. A single rope of PA (elastic polyamide) is tied around the cod-end to close it. (Figure 1).

The entire length of the trawl net is usually 58 m and the mouth circumference (stretched circumference at the fishing line) is about 61 m. The vertical opening of the gear is 1.3 m (0.7 to 1.6 m) and the horizontal opening (at spreaders) is 14.4 m (9 to 15 m), according to measurements made to three 1:8 scale models of representative Hellenic

bottom trawl gears that were tested at the North Sea Center flume tank (Hirtshals, Denmark) (ADAMIDOU & KALLIANIOTIS, 1997).

Regarding the ropes where the net is mounted, the float line is about 32 m long, 18–28 mm thick and is made of PA or MAN (Manila fiber); the ground rope is about 48 m long, 40 mm thick and is made of PA+Fe or PP (polypropylene) and Fe. The trawl net has no spreading wires; the net is joined directly to the spreaders. The sweeps are made of PA+Fe or MAN+Fe; their length ranges from 180 m to 280 m and their thickness from 24 to 50 mm. The otter boards of the traditional trawl are oval or rectangular and weigh 200 to 400 kg depending on their material. Every time that a tow takes place only one trawl net is towed.

Bottom trawl fisheries in Hellas are multi-species fisheries. The main target species or group of species are closely related to the season, depth (POLITOU *et al*., 2003) and substrate while the geomorphology of the bottom is an important ruling factor (KALLIANIOTIS *et al*., 2004). However, the most important species in terms of both landings and value are *Merluccius merluccius, Mullus barbatus, Parapenaeus longirostris, Nephrops norvegicus.*

Boat Seine

A commercial boat seine net operating in Hellenic waters consists of four main sections: the cod-end, the bag, the main body or shoulders and the relatively long wings (Figure 2a). The total length of the net ranges from 200 to 440 m and the stretched circumference of the mouth opening is 36 - 129 m. The bag is the central part of the net. It is 13-40 m long and the netting stretched mesh size is 20-28 mm. It consists of 8-16 rectangular pieces of netting of the same mesh size and twine thickness. The rearmost part of the bag is the cod-end, which is 1-7 m long, and the netting stretched mesh size is 16-20 mm. Shoulders are made of two half sections. The length of the shoulders varies from 11 to 70 m and the stretched mesh size from 24 to 60 mm. They consist of 2-10 rectangular pieces of netting with different mesh sizes and twine thickness. The wings are the longest part of the net representing 75% of the total length of the gear. They are also made of two half sections. They have a length of 144 to 400 m and a stretched mesh size of at least 600 mm. At the wings and shoulders there is a strengthening piece of enforced netting that is used to join the main netting with the headline and the ground rope and to prevent damage to the main netting. A spreader is used at the end of each wing to attach the netting to the hauling ropes. The headline and ground

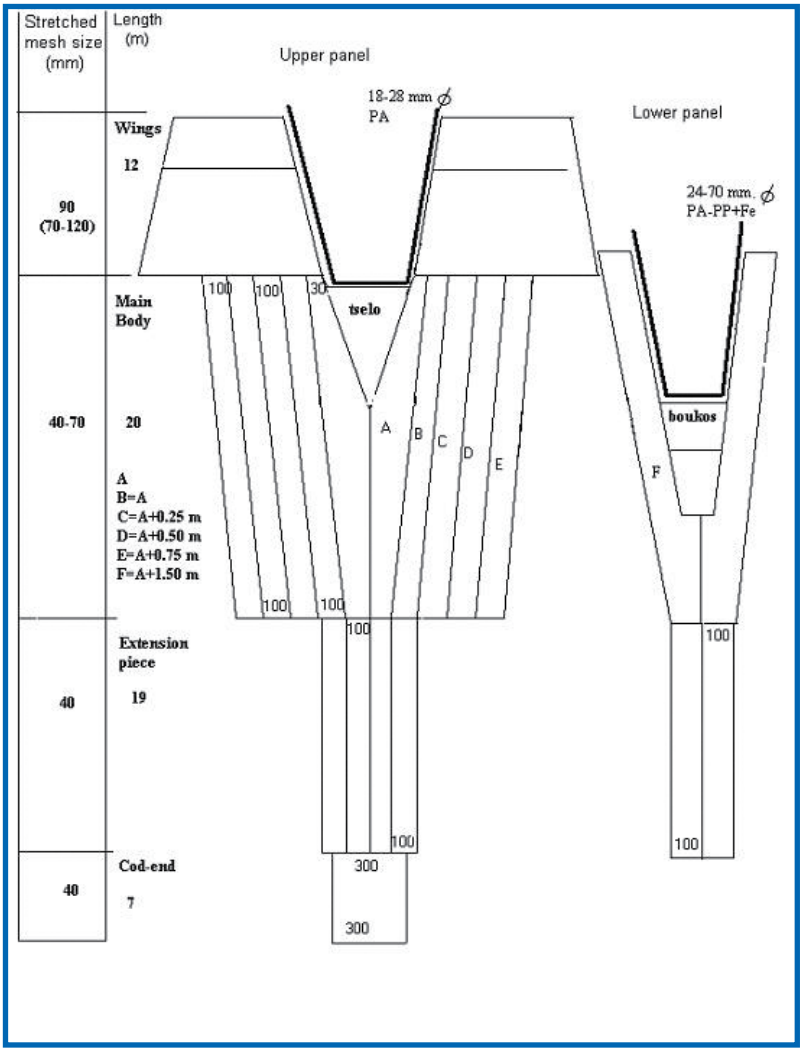

Figure 1: Design and technical characteristics of traditional greek trawlnet (Photo: A.ADAMIDOU).

rope are made of braided PA or PP rope and have a thickness of 6-12 mm and a length of about 600 m with the ground rope being slightly longer. The rigging of the gear is strongly related to the species targeted and the geomorphology of the fishing area. Oval and cylindrical floats are usually used in the headline for buoyancy and lead weights are used in the ground rope for weighing down. Floats and weights increase progressively from the wings to the bag. An important component for the capture efficiency of boat seines is the long hauling ropes, of maximum length 700 m, extending from the wings, which are used to encircle a large area. No doors are used for the operation of the gear. The technical details of a typical boat seine net are illustrated in Figure 2a.

The boat seine operates close to the coastline fishing grounds (< 0.5 mile) at depths < 50 m fol-

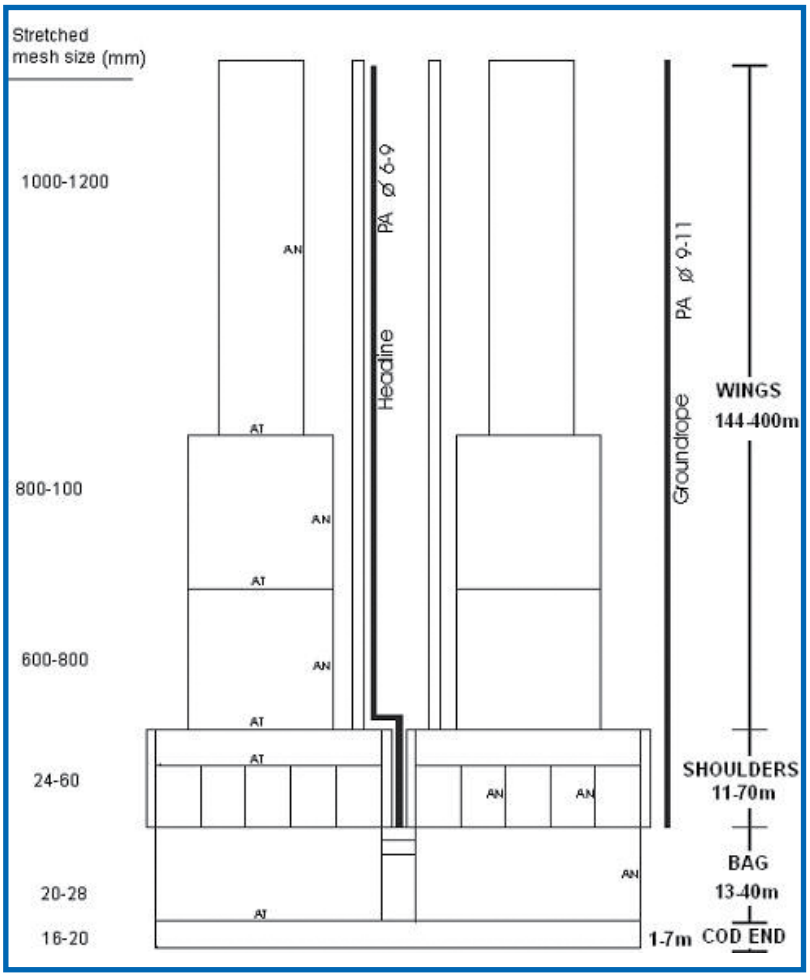

Figure 2(a): Design and technical details of a typical boat seine net (by A. ADAMIDOU).

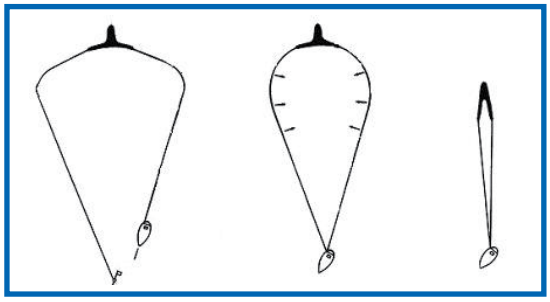

Figure 2(b): A plan of the operation of the boat seine gear (from SAINSBURY, 1996).

lowing more or less pre-defined hauls. The vessel carries out one-day trips, starting shooting one hour before sunrise until one hour after sunset. The shooting of the gear begins by setting an anchored buoy within 70 m from the coast. The vessel steams in slowly with approximately 5m/min. The hauling ropes of one side are laid out, the net follows and equal number of ropes for the other side is then laid out. In this way the gear encircles a relative large area in more or less a triangular pattern. The vessel courses back and when it reaches the anchored buoy, the first and the last ropes are hauled in slowly by the winch to guide the fish into the net. When the aft part of the bag comes to the surface it is pulled on to the boat by hand (Figure 2b) (ARMENI-AGIOBLASSITI, & ADAMIDOU, 1997). The gear activity strongly depends on the weather conditions and on the geomorphology of the fishing area. It is most efficient on flat bottoms with a smooth inclination where long ropes can be used (a 10 m depth difference between the mooring and the fishing place is required). Boat seines are also used in rougher grounds, but then with shorter ropes while they cannot operate on rocky bottoms since the net can be damaged very easily (LEFKADITOU & ADAMIDOU, 1997).

The target species for the boat seine fishery considered in general for Hellenic Seas are: *Spicara smaris* as the primary target species, while *Sardina pilchardus*, *Boops boops*, *Mullus barbatus*, *Loligo vulgaris* and *Pagellus erythrinus* as the secondary target species. (KARLOU-RIGA *et al.,* 1997; FISHERIES LABORATORY, 2001; PETRAKIS *et al.,* 2001, KALLIANIOTIS *et al.,* 2000).

Dredges

Dredging is not a widespread fishing method in Hellenic coastal fisheries. The related fishing gears are small and light and are used mainly for harvesting bivalve molluscs and sponges. Two dredge types are used, one for bivalve molluscs which is called "argaleios", and another for sponge-fishing called "gagava".

Bivalve dredge or "Argaleios"

The "argaleios" consists of a triangular metal frame up to 0.2 cm thick that has the sidebars curved at the end (Figure 3). The lower bar of the frame is up to 1.2 m long and may have a raking bar with or without teeth. A twine netting bag is attached behind the frame to collect the catch. The netting bag is up to 1.5 m long and the mesh size is over 70 mm (stretched mesh). The overall weight of the gear cannot surpass 12 kg. The "argaleios" can be towed either by hand or from a vessel by a towing rope tied to the eyelet at the top of the triangular frame. It is used on even seabeds at depths from 1 to 20 m and the target species are the smooth scallop (*Chlamis glabra*) and the smooth clam (*Callista chione*), (*Modiolus barbatus).* The gear is mainly used in the Thermaikos Gulf and to a lesser extent

Figure 3: A typical bivalve dredge or Argaleios (Photo: A. ADAMIDOU).

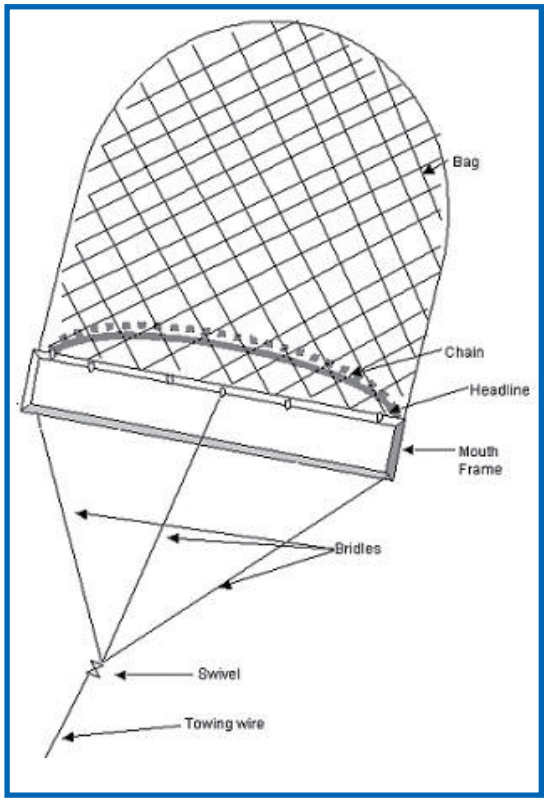

Figure 4: A rough drawing of a sponge dredge or gagava (by A. ADAMIDOU).

in the Saronikos and the Pagasitikos Gulfs.

Sponge dredge or "Gagava"

A rectangular mouth frame made of wood or metal tubing, to which a holding bag of twine netting is attached, constitutes the "gagava" (Figure 4). The frame is about 2 m wide, 0.5 m high and 2.5-3 cm thick. The holding bag has a constant width proportional to the frame, its length is 4 to 8 m and the mesh size is 300-340 mm (stretched mesh). It is tied directly to the upper and side part of the frame while, at the lower part, a chain of 2.5-2.6 m is connected and the bag is attached to the chain. The bag is emptied either by loosening the end line or by lifting it from the rear to drop the catch from the mouth. The overall weight of the gear is up to 50-60 kg. The "gagava" is dragged along the seabed by a towing wire that is linked to the frame by three ropes (two at the lower and one at the upper part of the frame), using a motorised winch with a towing speed of 2 knots/h. It is used mainly in sponge fishing at depths from 10-50 m on an even seabed. The gear is traditional and very famous in sponge fishing in the south-eastern Aegean Sea (Dodekanisos area) but nowadays its use is limited.

ENCIRCLING GEARS

Purse seines

Purse seining is one of the oldest fishing methods activated all around the world mainly on the coast until 1950 (HAYES *et al*., 1996, LOVE, 2006). After that period, the introduction of synthetic fibres in nets' manufacture, the modernisation of ships and their equipment and the use of electronic systems to detect fish catch, made the fishery more dynamic, and it moved also to the open sea. In the Mediterranean all the countries use purse seining intensively. The fishery is realised either during the night with the use of artificial light, which is also the most usual method, or during the day mainly in seasonal passages of migratory fishes. The differentiation between the two kinds of fishery consists of the characteristics of the gear used, the target species, the season, the fishing grounds and the legislation. The philosophy of purse seining is to gather species that usually form schools, surround them by a long wall of netting, purse the netting through the purse line creating a net open at the top and closed at the bottom trapping the fish.

Night purse seine

Commercial night purse seine gear operating in the Hellenic waters consists of two main sections: the main body and the cod-end. An auxiliary piece of netting is attached to the two ends of the main body to help the hauling of the gear. The main body of the night purse seine gear consists of 8-20 oblong pieces of netting ("ferses" in Hellenic), each being 400 meshes wide and joined one below the other. The netting stretched mesh size of the main body is 14 -28 mm. However, the two upper and two lower oblong pieces usually have a bigger mesh size (32 -90 mm stretched mesh) and

Figure 5(a): Lamp rafts at the deck of a purse seiner (Photo: A. CHRISTIDIS).

Figure 5(b): The large rowing net boat holding one end of night purse seine net during the setting of the gear (Photo: A. CHRISTIDIS).

Figure 6: The hauling of the night purse seine net (Photo: A. CHRISTIDIS).

are narrower compared to the pieces of the main body and are made of thicker twine. The cod-end consists of 4-19 pieces, is placed either at the centre of the main body or at the side and is made of thicker twine compared to the main body netting. The length of the gear ranges from 450 to 760 m (mounted), the stretched height from 80 to 120 m and the hanging ratio of the headline to the main body netting is 5-33%. The headline and the lead line are usually made of PA or PP, are 10-16 mm thick and the lead line is usually 5-15% longer than headline. A large number of plastic floats placed at close intervals on the float line ensure that the upper part of the net will always be at the water's surface. At the lead line rustproof metallic rings are connected at equal distances by small ropes of 0.5-2.5 m long. The number of rings is determined by the length of the gear (usually 60-135 rings). A wire cable -the purse line- passes through the rings and closes the bottom of the purse seine at the end of the gear operation.

The operation of the night purse seine in Hellenic waters comprises one "mother vessel", one large rowing net boat and several lamp rafts (Figure 5a) as this type of fishery relies on light attraction. When a school of fish is detected, usually by the echosounder, the lamp rafts are released on to sea to concentrate the fish. Afterwards, when the concentration of fish under the lamp rafts becomes adequate, the large rowing boat holds one end of the net (Figure 5 b), the "mother vessel" encircles the fish with the net and returns to the point where the large rowing boat waits to take the other end of the net. The "mother vessel" begins to winch in the purse line, closing the bottom of the seine and forming a bag-like net around the fish. The other lines are also winched in, reducing the space inside the net, which is then brought alongside the "mother vessel" (Figure 6). Using dip nets, scoops or other appropriate tools the crew take the fish on board the ship and place them in large ice basins.

The main catch of night purse seines consists of sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicholus*), chub mackerel (*Scomber colias japonicus*), horse mackerel (*Trachurus* spp.) and bogue (*Boops boops*) (VIDORIS *et al.*, 2001)

Day purse seine

A small number of recordings exist for the day purse seine gear. It consists also of the main body, the cod-end and the auxiliary piece of netting used for the hauling of the gear. The main body consists of oblong pieces of netting each being 400 meshes wide, joined one below the other but a fewer

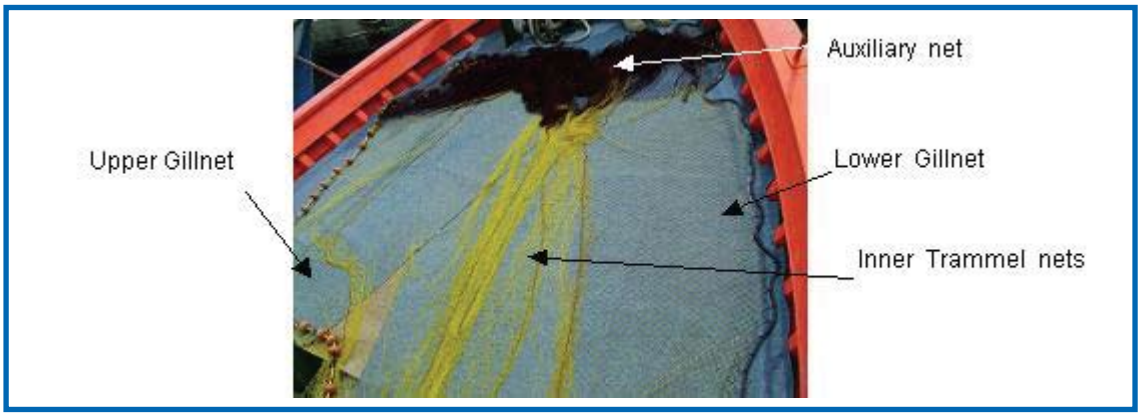

Figure 7: A part of a small surrounding net (Photo: A. ADAMIDOU).

pieces than the night purse seine; they are usually 5-9 which makes the gear shorter. The netting stretched mesh size of the main body is 40 mm and the netting twine is thicker. The two upper and two lower oblong pieces are narrower compared to the pieces of main body, are made of thicker twine and have the same or a bigger mesh size (72 mm stretched mesh). The cod-end consists of 5-7 pieces, is placed usually at one side of the main body and is made of thicker twine compared to main body netting. The length of the gear is up to 800 m (mounted), the stretched height up to 120 m but most commonly 70-80 m and the hanging ratio of the headline to the main body netting is 15%. The headline and the lead line, usually made of PA or PP, are 10-16 mm thick. The flotation, the sinking as well as the purse rings and purse line follows the same strategy as for the night purse seine.

The operation of the day purse seine is the same as the night purse seine without the use of the lamp rafts. The main catch consists of species such as: *Sarda sarda, Euthynnus alletteratus, Katsuwonus pelamis, Auxis rochei, Orcynopsis unicolor, Pomatomus saltator, Seriola dumerilii, Argyrosomus regius, Coryphaena hyppurus*.

Small surrounding net

The small surrounding nets used in Hellas named 'kouloura' are constituted from 1 to 9 oblong nets ("ferses" or "kanatia" in Hellenic) that are connected vertically. The nets can be all gill nets, or all trammel nets or a combination of these (gill nets for the first and last net; trammel nets the inner ones) (Figure 7). The stretched mesh size ranges from 44 to 72 mm. The length of the nets ranges from 250 to 500 m and can be equal or increased from the upper to the lower net. The nets are connected through lacing ropes. On each lacing rope the last part of the previous and the first part of the next net are rigged. The length of the lacing ropes is equal or little longer than the nets that are connected. The first and last oblong net is connected to the headline and lead line, respectively. An auxiliary piece of netting exists at the two sides of the surrounding net to facilitate the hauling of the gear. At the headline, a sufficient number of floats are placed with increased frequency providing the adequate buoyancy to maintain the upper part of the net at the water's surface during the fishery. The lead line is supplied with weights to ensure the vertical position of the net in the water.

The small surrounding net is used mainly for pelagic and semi-pelagic species that are shoaling (*Sarpa salpa, Mugil* spp., *Sarda sarda, Katsuwonus pelamis, Pomatomus saltatrix*) however, when it is used at depths lower than the height of the gear it fishes also demersal species. When the target species is detected, an anchored buoy is set in the water with the one end of the net attached to it. The ship, following a circular course, leaves the rest of the net, surrounds the school of fishes and returns to its initial place. Then, the net is gathered simultaneously from the two ends. Thus, the fishes are trapped in a space that is continually reduced. The fishing operation lasts half to one hour and the depth of fishery ranges from 4 to 65 m with 4-30 m being more usual. The gear is used mainly in the northern and central Aegean Sea.

STATIC GEARS

Nets

Fishing with nets is one of the most widespread fishing techniques used in ancient times. Fish may be caught in nets gilled (mesh behind opercula), wedged (mesh around the body) or tangled (by external protrusions without the body penetrat-

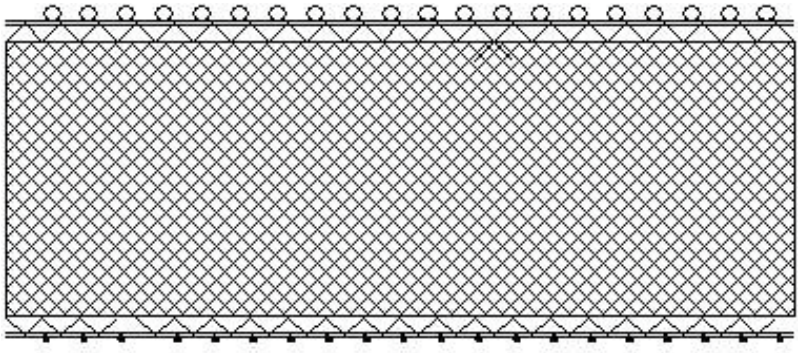

Figure 8(b): A rough drawing of a gillnet (by A. ADAMIDOU).

Figure 8(a): The upper part of a gillnet (Photo A. ADAMIDOU).

ing the mesh) (HAMLEY, 1975). The way that a fish can be caught depends on the mesh size and the tightness of the netting that is closely related to the hanging ratio (length of float line or lead line divided by the length of unmounted, stretched net). Fishing with set nets is well developed in Hellas since nearly all vessels of small-scale fishery use them for several fisheries (drift nets are prohibited by national legislation). The types of set-nets used mostly are: gill nets, trammel nets and combined nets.

Gill nets

A gill net is a single, rectangular sheet of netting hanging on a rope along its upper and lower part (on float line and lead line, respectively) (Figure 8). Sometimes, side cords are attached to each side end. The net is held vertically in the water owing to the combined action of floats and weights. A gill net can be used singly or most usually several nets are joined in fleets. It can be set in many ways depending on the target species and the type of seabed. The most frequent ways are: at or below surface, on the seabed, or in mid-water.

Concerning gill nets that are used in Hellas, the webbing is made of multifilament twine (monofilament twine is not allowed in Hellenic fishery). The length of each mounted gill net ranges mainly from 40 to 220 m; the depth ranges from 50 to 100 meshes when it targets demersal species while for pelagic and semi-pelagic species it ranges from 200 to 400 meshes. The hanging ratio can vary from a loose 0.25 (for lobster) to a tight 0.75 (for bogue, picarel, mackerel) while 0.5 is the most common for demersal species (mullets, hake, sea breams). The mesh size varies widely depending on the size and species being targeted. Floats of expanded PVC having a ring, cylindrical or egg shape are attached to the headline to maintain the buoyancy. Weights, usually steel, with a ring or cylindrical shape are attached to the lead line to ensure bottom contact even though lead-core lead lines have become more popular to avoid the catching on obstructions. The size and the frequency of the floats depend on the mesh size – they need to be slightly larger than mesh opening- and the depth at which the net is used. The surface gill nets need more floats and fewer weights while the opposite is necessary in bottom gill nets. Suitable mooring (usually stones) is used to fix the net to the bottom and plastic buoys to give lift and mark the position of the net.

Gill nets are used all around the Hellenic coasts with a high level of differentiation among them concerning the features of the gear, the target species and the way of deployment. However, the most common types (metiers) in gill net fishery that take place all over the Hellas are the ones targeting: red mullets (*Mullus* spp.), hake (*Merluccius merluccius*) and/or mackerel (*Scomber* spp), bogue (*Boops boops*) or picarel (*Spicara smaris*). The most important characteristics of these fisheries are as follows:

Gill nets for red mullets are usually 50-100 m long, 40-60 meshes deep and the mesh size ranges from 32 to 52 mm (stretched mesh). *Mullus surmuletus* is caught at bottoms enclosed between rocks and seagrass meadows, between 5 and 30 m depth while *Mullus barbatus* are caught mostly on seagrass meadows, muddy and sandy bottoms at 10-60 m depth. Nets are set once or twice a day, before sunrise and/or after sunset and stay in the water for 2-3 hours. The fishing period is from June to November.

Gill nets for hake and mackerel are usually 100-250 m long, 60-100 meshes deep and the mesh size ranges from 52 to 72 mm (stretched mesh). Nets are set on muddy, seabeds at 60-400 m depth. They are set before sunset and hauled before sunrise and stay in the water for 10-12 hours. The fishing period is from April to September.

Gill nets for bogue or picarel are usually 100-250

m long, 60-300 meshes deep and the mesh size ranges from 36 to 52 mm (stretched mesh). Nets are set on sandy seabeds and on seagrass meadows at 20-100 m depth. They are set once or twice a day, before sunrise and/or after sunset and stay in the water for 2-3 hours. The fishing period is mainly from May to October.

Trammel nets

Trammel nets are made of three rectangular sheets of netting in parallel order, that hang jointly on a single float line and lead line along their upper and lower part, respectively (Figure 9). The inner sheet has smaller mesh size than the outer ones and larger height to be loose enough. Thus, when a fish confronts the net it goes through the large mesh of the outer sheet, pushes the loose inner sheet, which consequently forms a pocket through the large mesh of the next outer sheet, and traps the fish. Floats and lead weights of appropriate size and frequency ensure the vertical position of the net in the water and the requested depth regarding the species targeted. Proper ballast is attached to each terminal end to fix the net on the bottom and a single line with a plastic buoy to mark its position in the sea.

Concerning the trammel nets used in Hellas, they are all bottom-set nets targeting demersal species. Their webbing is made of multifilament twine; their mounted length ranges mostly from 40 to 220 m; the depth of the outer panels ranges from 0.60 to 1.6 m with the inner sheet being 1.6 times deeper. The mesh size of the inner sheet varies widely depending on the size and species being targeted and is usually 5 times less than that of the mesh size of the outer sheets. The floats and weights are of the same types as those used in gill nets as well as those used for mooring and the buoy. They are set singly or in fleets in various configurations depending on the current conditions, type of seabed and target species.

Trammel nets are the most popular fishing gear in the Hellenic small-scale fishery. They are used all around Hellas, with many differences in the technical characteristics of the gear and the target species. Trammel nets usually target a group of species. The most common trammel net fisheries (metiers) in Hellas are the ones targeting: cuttlefish (*Sepia officinalis*), shrimps (*Melicertus kerathurus*), lobsters (*Palinurus elephas*) and common dentex (*Dentex dentex*), red mullet (*Mullus spp.*), common sole (*Solea solea*), large species of Sparidae family (*Pagellus erythrinus, Diplodus sargus, Pagrus pagrus, Sparus aurata*). The most important characteristics of the trammel nets used in these fisheries are as follows:

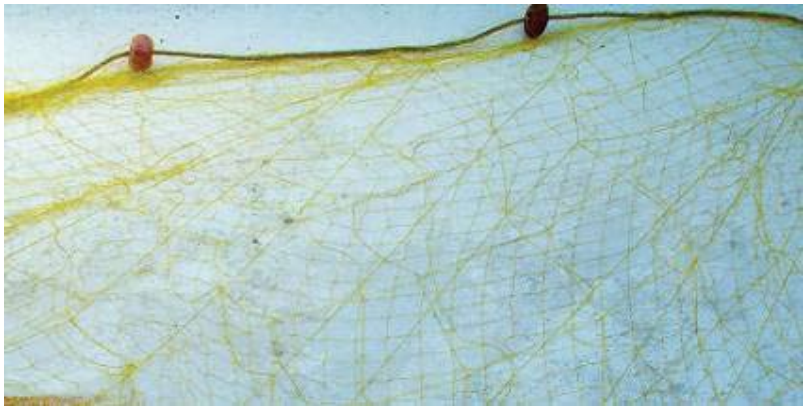

Figure 9: The upper part of a trammel net (Photo: A. ADAMIDOU).

The trammel nets for cuttlefish are usually 50-100 m long, the depth of the inner sheet is 50-60 meshes and of the outer ones 6.5-7.5 mesh. The most common mesh sizes are 60-72mm and 300-360 mm (stretched mesh) for the inner and outer sheets, respectively. The hanging ratio is usually 0.5. Nets are set on muddy seabeds and seagrass meadows at depths from 5-30 m more often. They are set before sunset and hauled before sunrise staying in the water for 12-14 hours. The fishing period is from February to May. They are used all around Hellas.

The trammel nets for red mullets are usually 100-220 m long, the depth of the inner sheet most frequently is 60 meshes and of the outer ones 7.5 mesh. The most common mesh sizes are 40-48mm and 200-240 mm (stretched mesh) for the inner and outer sheets, respectively. The hanging ratio is usually 0.5. Nets are set on nearly all types of seabed at depths from 20-200 m. They are set once or twice a day, before sunrise and/or after sunset and stay in the water for 2-3 hours. The fishing period is from April to September. They are used all around Hellas.

The trammel nets for large species of the Sparidae family are usually 100-350 m long, the depth of the inner sheet most frequently is 60 meshes and of the outer ones 7.5 mesh. The most common mesh sizes are 60-80 mm and 300-400 mm (stretched mesh) for the inner and outer sheets, respectively. The hanging ratio is usually 0.5-0.6. Nets are set on any type of seabed at depths from 30-300 m. They may be set once, before sunset and hauled before sunrise staying in the water for 12-14 hours or twice a day, before sunrise and/or after sunset and stay in the water for 3-4 hours. The fishing period

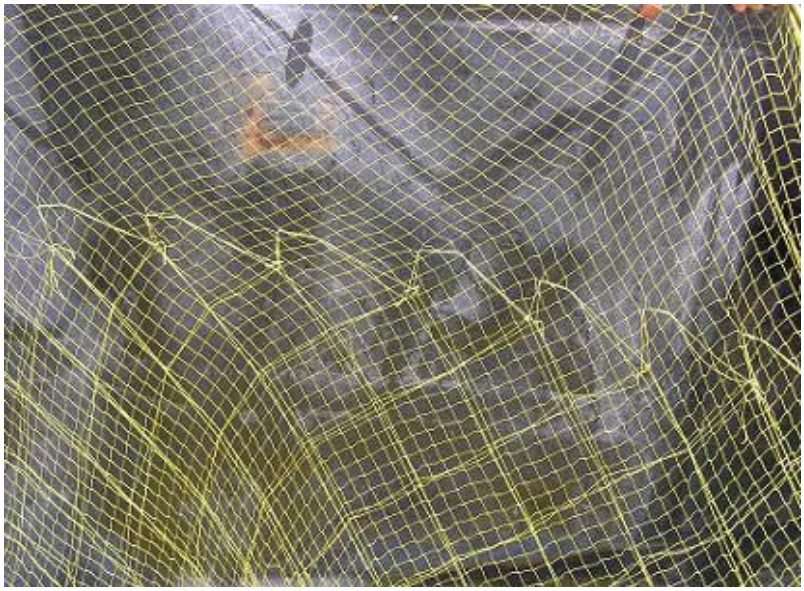

Figure 10: The join of a gillnet and a trammel net at a combined net (Photo: A. ADAMIDOU).

is almost all the year except for winter. They are used all around Hellas.

The trammel nets for lobster and common dentex are usually 100-220 m long, the depth of the inner sheet most frequently is 50-60 meshes and of the outer ones 7.5 mesh. The most common mesh sizes are 60-90 mm and 300-400 mm (stretched mesh) for the inner and outer sheets, respectively. The hanging ratio is usually 0.4-0.5. Nets are set on rocky and mäerl seabeds at depths from 30-150 m. The soaking type is 10-24 hours. The fishing period is from May to September. They are used mainly in the central and southern Aegean Sea and in the Ionian Sea.

The trammel nets for shrimps are usually 50-100 m long, the depth of the inner sheet most frequently is 60 meshes and of the outer ones 4.5-6.5 mesh. The most common mesh sizes are 40-48mm and 200-240 mm (stretched mesh) for the inner and outer sheets, respectively. The hanging ratio is usually 0.5. Nets are set on muddy seabeds at depths from 5-30 m. They are set once or twice a day and stay in the water for 3-8 hours. The fishing period is from April to June and from September to November. They are used mainly in the northern and central Aegean Sea and in the Ionian Sea.

The trammel nets for common sole are usually 50-100 m long, the depth of the inner sheet is 40-60 meshes and of the outer ones 4.5-5.5 mesh. The most common mesh sizes are 68-90 mm and 330-420 mm (stretched mesh) for the inner and outer sheets, respectively. The hanging ratio is usually 0.4-0.5 (ADAMIDOU *et al*., 2004). Nets are set on sandy and muddy seabeds at depths from 10-70 m more often. They are set before sunset and hauled before sunrise staying in the water for 12-14 hours. The fishing period is from October to April. They are used mainly in the northern and central Aegean Sea and in the Ionian Sea.

Combined nets

A combined net is made up of a gill net at its upper part and a trammel net at the lower. Concerning its structure, it can be either (A): a gill net having at its lower part two sheets of netting with large mesh size attached to the opposite sides (Figure 10); or (B): two separate nets, a gill net and a trammel net, that hang vertically one after the other connected to a common rope. In the second case, the net has three mounting ropes, a float line (where the gill net hangs), a lead line (where the trammel net is attached) and a connection line in between where both nets are attached. The combined nets target species in the whole water column, pelagic and semi-pelagic that may be caught by a gill net and demersal species caught by a trammel net. They maintain their vertical position in the water by means of floats and weights as in the other set-nets. The floats and weights are of the same types as those used in the other set nets as well as those used for mooring and buoyancy.

The combined nets used in Hellas are usually constructed according to the first of the aforementioned ways; their mounted length is 100-300 m for the majority of the nets and the depth is 100-300 meshes. The depth of the nets joined in a fleet is often not the same, but increases gradually from the first to the last net. The trammel net may cover 20-50% of the entire depth of the net. The mesh size varies mostly from 40 to 64 mm (stretched mesh). Floats and sinkers are of the same types used in all set-nets but are placed with greater frequency on the respective ropes. An auxiliary rope is connected to the lead line to support it on rough bottoms. Combined nets are set usually singly or in small fleets, on any type of seabed, at depths from 10-100 m. They are often arranged around rocky areas or vertical to the shoreline forming a half circle targeting species that are travelling along the shore, or across known fish movement paths. Bogue (*Boops boops*), picarel (*Spicara* spp.), Atlantic bonito (*Sarda sarda)*, saddled sea bream (*Oblada melanoura*), red mullets (*Mullus* spp.), gilthead sea bream (*Sparus aurata*) are the main target species. The gear is very common in the central and the southern Aegean Sea

Figure 11(a): Circle hook with a big eye (Photo: A. ADAMIDOU).

Figure 11(b): Basket with hooks hung at its mouth (Photo: A. ADAMIDOU).

Figure 11(c): Reflectors used to enable the localization of the surface purse seine (Photo: V. LEKKAS).

and in the Ionian Sea.

Long lines

Long lines, as the name implies, is a fishing gear that consists of a main line of long length to which many branch lines are attached at equal intervals. Each branch line has a baited hook at its end. The length of the branch lines, the distance among them and the size of the hook depends on the target species. The main line and the branch lines are monofilament twines made by PA with the main line being thicker than the branch lines. In certain cases, the mainline is made of a woven rope of varied thickness while the branch lines from wire. The branch line may be tied to the main line or connected to it by a swivel or a swivel plus a snap-on connector. The hook is characterized by a number that decreases as the size of the hook increases. The shape of the hook also varies; it may be a "J" type that is the most common one, a circle hook or circlular hook with a big eye (Figure 11a). The choice of bait also has a direct relation to the target species. Many fish species, like mackerel and sardine, round sardinella, squid, octopus, mussels, sand worms are used (the entire fish or pieces of them) fresh, frozen or salted. For easier storage and use of the gear, the main line is placed in a coil in plastic baskets while the hooks are hung on cork at the mouth of baskets (Figure 11b). Each basket allocates a certain number of hooks. Long lines are distinguished into two main categories: a) surface long lines b) bottom long lines. Surface long lines are also divided into drifting and set while bottom long lines are always set.

Surface long lines

The surface long lines are used at or near the surface of the sea and are separated into drifting and set. They are mainly used for the fishery of big pelagic species (swordfish and thunnidae), therefore, the main line is very long and thick and the branch lines are usually double. The intervals between the branch lines are also large. The hooks are big usually circlular ones with an eye.

Drifting surface long lines

The drifting long lines do not have any stabilisation equipment, they are left to drift with the sea currents. Their localization is usually electronic (by GPS) with the help of reflectors. The main line is 1.5-2.5 mm thick, the branch lines 1-2 mm thick and the space between them is 20-45 m. The nominal number of hooks is 3-6. At appropriate intervals (every 5-10 hooks) plastic buoys of 5-10 l (litres) are connected to the main line, while at the two ends and in the middle of the main line

large buoys of 20 l, joined to black flags and reflectors, are connected to enable the localization (Figure11c).

Set surface long lines

The set surface long lines have stabilisation equipment (weights) at one or even both ends. The main line is 1.5-3 mm thick, the branch lines 1-2 mm thick and the space between them is 20-45 m. The nominal number of hooks is 3-6. At appropriate intervals (every 5-15 hooks) plastic buoys of 1.5-3 l are connected to the main line and weights of 0.5 kg; while at the two ends and in the middle of the main line large buoys of 20 l and weighing 5-10 kg are also connected. Flags and reflectors at the ends of the long line enable the localization (Figure 11c).

Bottom long lines

The bottom long lines are always set. They consist of the main line with suitable weights (usually stones) to fix the long line to the bottom and plastic buoys to give lift and mark the position of the long line at both ends. Smaller weights are also placed at regular intervals along the main line, which keep it on the seabed. Sometimes floats are also placed at regular intervals in the interspaces of the weights. Thus, the main line becomes meandering. According to the size of hook, they are divided to small, medium and large ones.

Small bottom long lines.

The nominal number of hooks is 12-16. The main line is 0.5-1 mm thick, the branch lines, 0.2-0.6 mm thick and the space between them is 2.5-5 m. They fish at depths from 20 to 100 m for large species of the Sparidae family (*Pagellus erythrinus, Diplodus sargus, Pagrus pagrus, Sparus aurata*).

Medium bottom long lines.

The nominal number of hooks is 8-12. The main line is 0.5-1.2 mm thick, the branch lines, 0.4-0.8 mm thick and the space between them is 5-8 m. They fish at depths from 80 to 180 m for larger species of the Sparidae family (*Pagellus erythrinus, Diplodus sargus, Pagrus pagrus, Sparus aurata*), dusky grouper (*Epinephelus marginatus*) and white grouper (*Epinephelus aeneus*).

Large bottom long lines

The nominal number of hooks is 3-7. The main line is 1-2.5 mm thick, the branch lines, 0.5-0.1 mm thick, sometimes made of wire, and the space between them is 8-11 m. They fish at depths from 200 to 700 m for hake (*Merluccius merluccius*), dentex (*Dentex dentex*), dusky grouper (*Epinephelus marginatus*), white grouper (*Epinephelus aeneus*), wreckfish (*Polyprion americanus),*greater amberjack (*Seriola dumerili),*blacktip grouper (*Epinephelus fasciatus*), and some species of Elasmobranchii.

Pots -Traps

Pots or traps are fishing gears in the form of cages, baskets or funnels that are set on the seabed, baited or not, for the capture of fish, cephalopods and crustaceans. Their shape may be cylindrical, rectangular or spherical with one or more entrances. They have a steel, wood or plastic frame covered by twine, plastic or wire netting and set out singly or in fleets. Pots are marked at the surface by a line with a buoy at each end. Ballast is used mainly at each end when pots are set in fleets. The basic principle of pots' operation is to attract the target species that enter the pot either for sheltering or for feeding, enabling their entrance into the pot and obstructing their escape. The pots may be hauled either by hand (in shallow waters or when a small number is used) or with lines (in deep waters) or using hydraulic haulers when pots are in fleets. The depth of hauling and the type of seabed depend on the target species. Pots are used by small-scale fishery; the amount of pots that will be used is determined by the size of the vessel and the number of crew. The soaking time varies from 10 hours to10 days. The most common types of pots used in Hellas are presented below.

Fyke net

A fyke net is a cylindrical trap with a cone-shaped end that consists of 2-5 metallic hoops covered with twine netting (Figure 12). Its length varies between 1.2 and 6.2 m. The hoops are made of galvanized steel wire with an external plastic coating, slightly flattened at the bottom in order to sit on the seabed. The diameter of the hoops range from 0.38 m to 0.60 m and their thickness is between 12 and 15 mm. A rectangular piece of netting of 40-44mm stretched mesh size, covers the hoops, is mounted on them and is tied up on one side forming a cone-shaped holding chamber. One or more netting funnels are placed inside the trap, mounted on the 1st and 2nd or 3rd hoop with direction from the mouth to the rear end of the fyke net. In this way the fish that enter the fyke net cannot escape and remains trapped in the holding chamber from where it is removed by the fishermen. A gill net of 6-8 m long and 15-20 meshes high is placed vertically at the entrance of the fyke net and leads the fish towards the 1st netting funnel. Fyke nets are usually used in pairs, being linked on the two sides of the guiding panel. They are set out in fleets of 20-50 pairs, either by hand or using a winch, in muddy bottoms and in seagrass

meadows, at depths from 5 to 30 m. A single line with a plastic buoy is attached to each side of the fleet to mark its position in the sea and ballast to fix the fleet on the bottom. Depending on the vessel's size, from 100 to 1 500 pairs of fyke nets are fished, with several fleets being deployed. They are left to fish from one to seven days depending on the fishing conditions. Afterwards they are retrieved, emptied and reset. The main target species of the fyke net is the common octopus (*Octopus vulgaris*) (northern Aegean Sea) (KALLIANIOTIS *et al*., 2001; LEFKADITOU *et al*., 2003), the European eel (*Anquilla anquilla*) (western Hellas) and other smaller fishes (mainly Gobiidae and Sparidae).

Figure 12: A typical fyke net (Photo: A. ADAMIDOU).

Fish pot

A fish pot has an ellipsoid shape with a flat bottom in order to sit on the seabed (Figure 13). The diameter at the wider end of the pot is 0.5-0.8m, the height is 0.5-0.8 m and the weight about 2 kg. It is made of galvanised steel wire 2.5-3 mm thick that is woven to form a mesh of 0.6-0.7 cm (bar length). The fish pot has a funnel-shaped entrance at its upper side. The opening of the entrance is reduced gradually as it goes down inside the pot, to allow fish to enter, but not to escape, unless they are smaller than the wire mesh size. Fish pots are baited and hauled, usually independently one from the other, at depths from 15m to 70 m on muddy or sandy bottoms or close to rocks. The bait is usually salted fish, cheese or yeast. A single line with a plastic buoy is attached to each fish pot to mark its position. Depending on vessel size, 30 to 100 pots are used. The soaking time is 12-24 hours. The pots are retrieved individually, by pulling up the buoy line with a hooked pole. The pot is emptied, re-baited and reset. The fish pots are used mainly in the south-eastern Aegean Sea (Dodekanisos area) and the main target species are: white sea bream (*Diplodus sargus*), black sea bream (*Spondyliosoma cantharus*), sharp snout sea bream (*Diplodus puntazo)* and groupers (*Epinephelus* spp.)

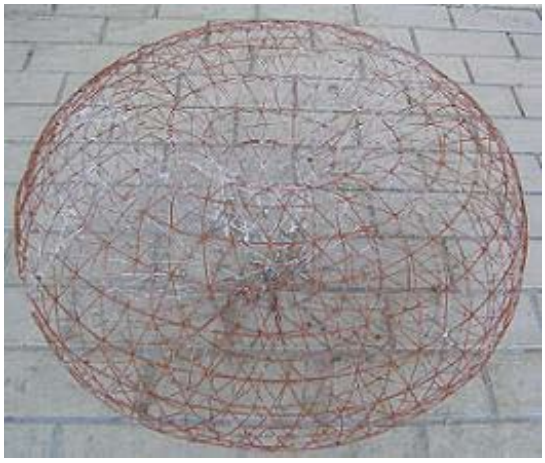

Figure 13: A typical fish pot (Photo: A. ADAMIDOU).

Crustacean pots

The Crustacean pots may be rectangular with a rounded or flat upper part or barrel-shaped. The rectangular pots are made of a frame of steel rods that is covered by twine netting of stretched mesh size 16-24 mm when it targets shrimps, 40 mm for crayfish and 60-80 mm for lobster (Figure 14). The barrel-shaped pots are made of horizontal slats fixed on 3-4 PVC hoops. The opposite sides are covered by twine netting of 48-80 mm (stretched mesh). A plastic funnel with a 20-40 cm opening at the upper part leads crustaceans inside the pots where the bait is placed. Small-sized fish or pieces of fish are the most common bait. Fishing for shrimps and lobsters is carried out at depths ranging from 70-130 m, on muddy (shrimp) or rocky (lobster) bottoms while for crayfish from 200-520 m. Crustacean pots are set in fleets. The soaking time ranges from 4 hours (crayfish) to 1 day (lobster). The number of pots used varies from 50 to 200 depending on the length of the vessel and the number of crew. The Crustacean pots are used mainly in the south-eastern Aegean Sea (Dodekanisos area) and in the central Aegean Sea.

Octopus pots

They are of the oldest type of pots, traditionally made of clay. Nowadays, lighter and more long-lasting materials are used such as plastic buckets or pipes (Figure 15). Their length is about 30 cm

Figure 14(a): Crustacean pots for lobsters (Photo: A. ADAMIDOU).

Figure 14(b): Crustacean pots for shrimps (Photo: A. ADAMIDOU).

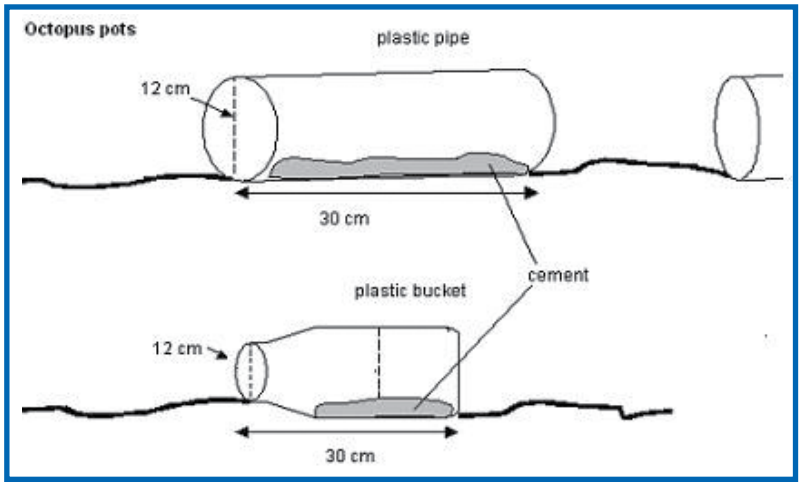

Figure 15: A rough drawing of octopus pots (by A. ADAMIDOU).

and their diameter 12 cm. A small amount of cement is placed inside the plastic pots at the side that is adjacent to the seabed to keep the pot on the bottom. Octopus pots are not baited and are set always in fleets of 50-100. They are set at depths of 10-70 m and the soaking time is 5-10 days. They are used in the northern and eastern Aegean Sea targeting the common octopus (*Octopus vulgaris*).

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