Contributed Papers

SESSION I: Chairman; Mr. N. L. Elder

Shallow-water Diving in Marine Ecology

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Since there are a number of popular books covering the more spectacular aspects of submarine life, this paper will be confined to some of the less obvious details. I will try to present the aqualung diver as the counterpart of the terrestrial ecologist with his notebook, camera, and sampling techniques.

Equipment: The aqualung, which is air-breathing apparatus, is the most generally useful type of equipment. It has a safe depth range of about 100 ft. without encountering special physiological difficulties, though greater depths are possible if extra precautions are taken. Recent American models have a full-face mask which leaves the mouth free to use a microphone. An Australian worker has recently designed an apparatus which allows "wire-less" conversation with the surface or another diver. Oxygen-breathing equipment has a greater duration and leaves no bubbles, but is not safe below 33 ft.

Photography: Assuming that a water- and pressure-proof camera case is available, three main problems are still to be met. Firstly, in most coastal waters suspended material greatly limits light transmission. Apart from reducing available light this makes the distance at which objects can be seen surprisingly short. For any large objects a wide angle lens thus becomes essential. A flash or other artificial light source is almost indispensable at depths below 60 ft. (monochrome) or 20 ft. (colour). Probably one of the most profitable fields of biological photography will be close-ups (3 ft. or less) of small organisms. Secondly, refraction at the water to glass interface makes objects appear one-third closer. This makes judging distance difficult and a reflex camera is probably the most satisfactory type. Thirdly, for colour photography, the spectral quality of the light tends to over-emphasize greens. The human eye automatically compensates for this effect but the camera does not, so that colour-correcting filters are necessary.

Animal Behaviour: It is possible to approach many fish to within touching distance and to photograph or observe them very closely. Usually many more species are seen than are caught by conventional fishing methods, but some relatively common fish, including the snapper, tend to be elusive. Some species such as the gurnard may bury themselves in sand, which may account for sudden changes in availability to fishermen. Plankton can be seen and identified just as readily as if they were in a sample tube at the surface. Except when large numbers are present one usually sees, not a continuous procession, but sporadic aggregations of individuals. Bainbridge (1952) has used an aqualung to study the swimming behaviour of *Calanus* in connection with his work on vertical migration.

Quantitative Investigation: The most successful work has been done on sedentary benthic organisms as in the Tasmanian scallop investigations (Fairbridge, 1953). Intertidal ecology can be carried out at high tide or extended below low-water mark (*e.g.*, Forster, 1954). Brock (1954) has made a line traverse estimate of reef fish, using a similar technique to that sometimes used by ornithologists. Some fish are relatively sedentary in their habits and I have noted small reef fish in the New Hebrides which remained in the same niche for at least six months.

Hydrography: Discontinuities in the water itself are often plainly visible. These may appear as changes in turbidity, mirror surfaces (Limbaugh and Richnitzer, 1955), or mixing layers with an irregular refractive index. In Hauraki Gulf I found that the lower limit of the thermocline at 10 fathoms was very plainly marked by an abrupt cessation of the suspended matter found in the superficial layer. Fig. 1 shows the level occupied by spawning snapper in relation to hydrographic information which was obtained by combined diving and bathythermograph observations. The change in temperature at the thermocline was readily detected by the diver even without a thermometer and the change from relatively turbid "Gulf Water" to clear "Oceanic Water" was very sharply defined.

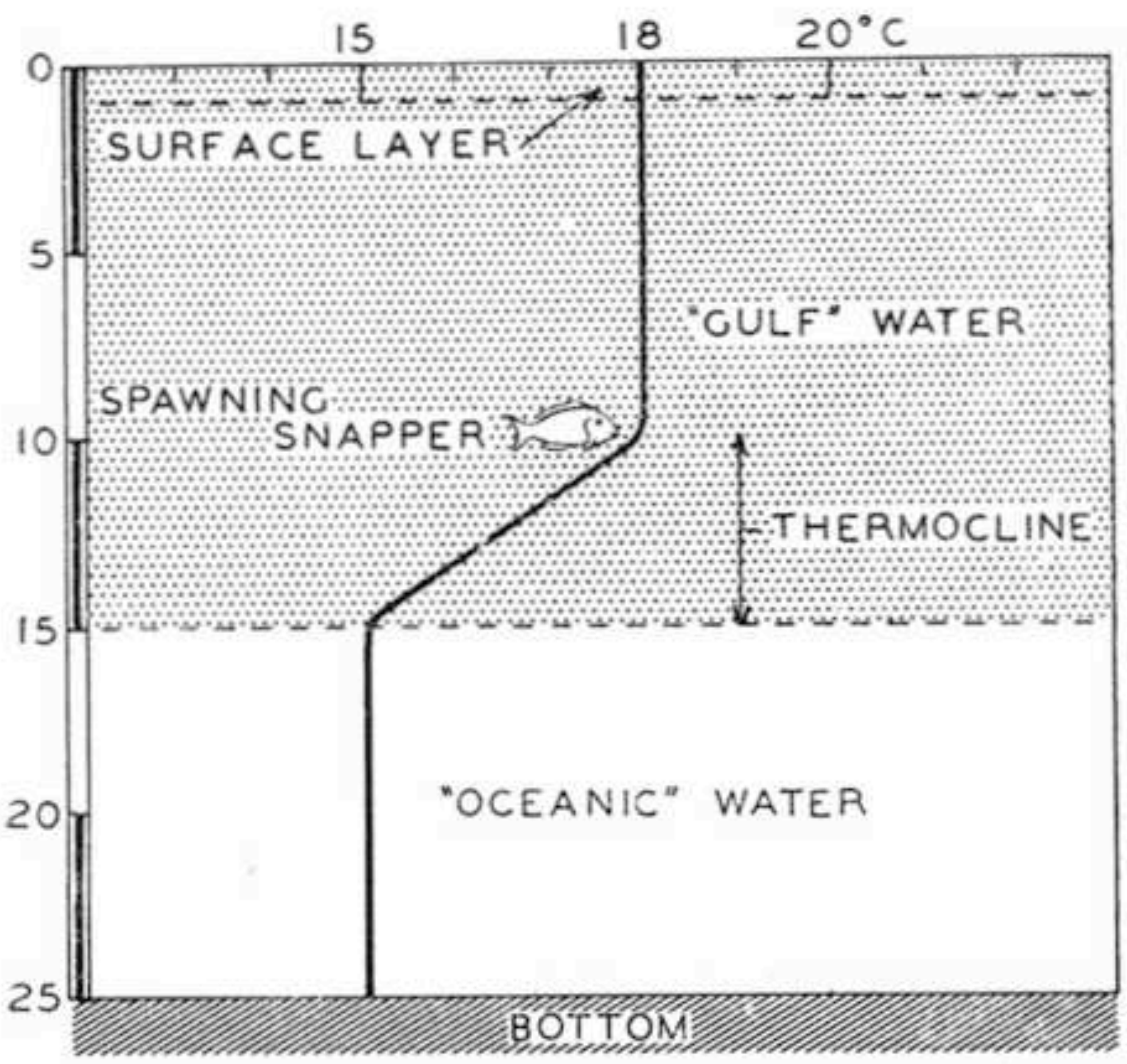

FIGURE 1.—*Structure of the thermocline in Hauraki Gulf. Note the sharp change in water transparency at 15 fathoms.*

Underwater Apparatus: The British films of a trawl in action have produced a convincing demonstration of the operation of commercial fishing gear. Many kinds of biological sampling can be similarly observed and their effectiveness tested, while the diver himself is often an effective substitute for elaborate apparatus.

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