INTERNAL ANATOMY

• The alimentary canal and associated structures are considered.

Mouth

• Different mouths are adapted for various feeding groups.

• Adaptations involve the size and placement of the mouth.

• Many fish are equipped with large mouth and big sharp teeth, some with large mouth with or without teeth or weak teeth but may be equipped with other structures that can hold prey or strain plankton out of water.

• Pods of small conical or cardiform teeth are seen in many species that are opportunistic in capturing a variety of animal prey.

Gills

• The gills lie behind the cavity in the pharynx.

• Commonly, the gills are 4 pairs but shark and ray may have 5-7 pairs of arches.

• Gill arches may be equipped with projections called rakers which vary from few numbers in predators (which may have rough prominences or denticles that aid in holding and swallowing) to extensive slender gill rakers in plankton feeders.

Teeth

• Teeth are borne on several of the head and face bones.

• Those in the upper jaw include the premaxillary, the maxillary, vomerine and platines while those in the lower jaw are called dentaries, glossohyal (on the tongue) and basibranchials (between the gills).

• Teeth are also borne on pharyngeal bones (upper and lower) which vary, ranging from small conical points to grinding plates.

Oesophagus

• The oesophagus in fish is short and distensible so that relatively large objects can be swallowed but microphagus fishes have less distensible tubes that those of predatory fishes.

• The oesophageal wall equipped with circular and longitudinal layers of striated muscles and column epithelium with mucous cells.

• Other features of oesophageal wall are taste but and gastric glands (in some fishes).

• There are modifications of oesophageal walls.

• Butter fishes have sac connecting to the oesophagus while in other fishes the oesophageal sacs are line with teeth (e.g *Pampus sp*.) which are attached to thin bone in the walls of the sacs.

• The sacs serve various functions in various species i.e production mucous, storage of food, modified for respiratory purposes Stomach

• The stomach is lacking in lampreys, hagfishes and some bony fishes including minnows (Cyprinidae).

• Also gastric glands are lacking and oesophagus empties directly into the intestines.

• The stomachs of fishes vary shapes such as U or V being essentially a bent muscular tube.

• Other common stomach shapes are bag-shaped, gizzard-like (mullets) and heavy-walled.

Intestines

• The intestines are long tubes and coiled or folded into distinct patterns in herbivorous fishes but short guts are obtained in carnivores while omnivore have guts of intermediate lengths.

• Lungfishes, polypterids, some primitive bony fishes as well as shark or related cartilaginous fishes posses spiral intestine.

• Jawless fish (parasitic lampreys feed on blood or juices of its prey. Such fishes have extremely thin walled and distended intestines.

• The associated organs attached to intestines are the pyloric caeca, liver, pancrease and air bladder

Taxonomy

• Use skeletal preparations prepared by dissection, by dermestid beetles, ants ot other organisms, or clearing of tissues and subsequent staining of bone by alizarin;
• Use soft X-ray to disclose skeletal features without destroying the whole fish specimen;
• Use chromosome numbers and morphology for which careful histological peparations must be made, often of developing gonad cells;
• Employ differences in behaviour, which demand quantification and careful analysis;
• Obtain accurate identification of parasites, for some of these are host-specific and thus may assist in identification of their hosts (when host-parasites relations and faunas are adequately known);
• Measures physiological differences among species and varieties, including those of biochemical nature such as protein analysis is by elecrophoresis.
• X-ray and alizarin preparations can be made from formalinpreserved specimens. Chromosomes studies usually require special treatment of fresh materials, as do parasites analyses. Biochemical differences also need fresh, even live, specimens. Sometimes sharp-frozen materials can be used, either as whole freezing dry ice and a suitable insulated container are useful in some field conditions.

Protein taxonomy

• Regarding protein taxonomy (Nyman, 1965a) or biochemical systematics (Tsuyuki and Roberts, 1966, the following summary was prepared by T.
D. Hes (Fisheries Research Station. St Andrews, New Brunswick):
• A type of protein, such as haemoglobin, which in different species has the same function, may show specific differences in the rates at which is migrates through a gel medium under the influence of an electric current.
• These differences in electrophoretic mobility reflect differences in the fine structure of these proteins which have a generic basis, and they may also be to a large extent independent of environmental factors.
• These characteristics, together with the fact that such differences can exist between species whose gross morphology may be very similar, emphasize the potential value of protein analysis in taxonomy.
• In marine freshwater fishes the proteins which have been most intensively studied include the haemoglobins (Sick, 1961), serum and plasma proteins (Nyman 1965s, b), muscle myogens (Tsuyuki and Roberts 1965, 1966; Tsuyuki et al., 1965) and organ proteins (Nyman, 1965a).
• The result of electrophoresis is the production of a pattern of bands that are revealed by staining represents one (at least) specific protein.
• The shown to be species specific (Tsuyuki and Roberts 1966). It has also been possible to identify hybrid individuals between species of which the parent patterns are known, its geographical range by minor differences in the patterns (Child et al., 1976; Brassington & Ferguson 1976; Child & Solomon 19770.
• Individual variation in the band pattern is also well established.
• In a few instances the genetic mechanisms determining the inheritance of different patterns in the same species has been determined (Sick, 1961), allowing different populations of the same species to be characterized by the gene frequency of the various alleles which, usually by a co-dominant effect, are responsible for the differences in band pattern.

• Although protein taxonomy requires facilities, techniques and some experience, there can be little doubt that it will become established as a valuable tool in the elucidation of taxonomic problems. (Hawkins & Mawdesley-Thomas (1972) and the papers by Ligny (1971), Avise (1974), Utter et al (1974) and Market (1975).

Collection of fish for taxonomic work

• What to preserve?

• The days are gone when new species often described from one specimen.

• At least 20 to 30 specimens should be collected from each locality. These samples are best selected at random, avoid equally taking only what seem to be the most typical specimens, or concentrating on extremes of colour, form, etc. both sexes are needed, and gonads should be left in the fish.

• As comprehensive a size range as possible is desirable.

• Extreme or aberrant specimens are of interest and should be collected, but they should be especially marked as atypical; often they will prove to belong to a different species.

• To find young stages, it is often necessary to fish in different places, as fish often change their habits and habitats as they grow.

• It does not matter how the fish are caught, provided that they are not damaged; long-spined species often have their dangerous spines broken off by fishermen, destroying most of their values as specimens.

• Whole individuals should be kept whenever feasible.

Labeling and recording

• It is essential to label individual fish or lost of fish immediately on collection.

• Serial numbers, written on a strip of good waterproof paper (high rag content) using a soft pencil or waterproof ink, can generally be fixed under the gill cover or in the mouth of individual specimens, or in the containers of lots of specimens, to correspond with the notes recorded at the time of collection in field notebook.

• It is a good plan to give a serial number to each fishing operation, followed by a serial number denoted differently (say in a circle) for the specimen, together with the initials of the collector.

How to preserve specimens?

• Formalin is generally a reliable preservative, after which they can be transferred to alcohol for lengthly preservation.

• Commercial formaldehyde (trade-name Formalin) is concentrated (about 40%) and must be diluted before use, I part formalin to 9 parts water (approximately a 10% solution of formalin) for most uses.

• Large fish need formalin of this strength or stronger (up to 20%), but small fish can be fixed in a more dilute solution (down to 5% formalin).

• The formalin bath can be reused but becomes diluted with use. Neutralized formalin is to be preferred, because ordinarily formalin will soften bones of fish after a time.

• It can be purchased ready neutralized or neutralized by adding about one level teaspoonful of household borax to each litre of preserving solution.

• The inconvenience of taking liquid formalin into remote field areas can be offset by carrying dry, powdered paraformaldehyde (e.g Trioxymethylene, Fisher Scientific Co, USA).

• One litre of neutralized 10% formalin is obtained by dissolving about 40g of the paraformaldehyde, together with about 8g of anhydrous sodium carbonate (Na_2CO_2) or other buffer and about a teaspoonful of ordinary powdered detergent (such as Tide) to aid in

solution, with a litre of water, at room temperature.
• This mixture is then used as ordinary 10% formalin.
• **Caution:** Formaldehyde is a cumulative external poison. Different people vary greatly is susceptibility, but all becomes sensitized after repeated exposure. Avoid contact of formalin with the skin, for example by using rubber or plastic glove.

Use of keys for identifying fish

• Specialists vary slightly in their ways of taking certain measurements and counts.
• It is desirable to ascertain how these were made: this may be stated in the preamble to the key, or n the book where it is found.
• The sizes of specimens on which the key is based (the sizes of specimens available are often given in the species description), as the key may be based on fish of one size only and allometric growth changes will affect proportional measurements.
• The topography of a typical spiny rayed fish indicating how the various measurements are made.
• Fin ray counts,
• scale counts,
• morphometric measurements to define body shape, gill raker number, teeth, and colour patterns are characters commonly used for identifying fishes.
• Ordinarily counts and measurements needed for identification are made on the left side of the fish.
• **SPINES:** True spines are single-shafted and of entire composition. They are designated by Roman numerals, no matter how rudimentary or how flexible they may be. Morphologically hardened soft rays (spiny in character) may be treated as spines, whether these be simple rays as in carp, or the consolidated product of branching, as in some catfishes (Ictaluridae).
• **SOFT RAYS:** soft-rays ate bilaterally paired and segemented and are usually though not always, branched or flexible. They are designated by Arabic numerals. In certain fishes (e.g Cyprinidae and Catostomidae) the count is of the principal rays only, to accord with general practice and because the rudimentary rays are difficult to ascertain. In these families the principal rays generally include the branched rays reaches to near the tip of the fin. In fishes such as Ictaluridae, Escocidae and Salmonidae, in which the rudimentary rays grade into fully developed ones, the total count is given. The last ray of the dorsal and anala fins, is often divided to the base, making it difficult to decide whether is should be 1 or 2 (it is better to yake it as 1, but record it as 1(-1) to see how it fits in with other people's keys).
• **CAUDAL FIN:** Count the number of branched rays and add 2 (for the 2 principal unbranched rays, above and below).
• **PAIRED FINS:** All rays are counted, including the smallest one at the lower or inner end of the fin base (good magnification is often needed). Sometimes a small ray (counted in pectoral but not pelvic) precedes the first well-developed ray (and may require dissection to be seen). In some fishes with reduced pelvics (e.g Cottidae) the spine may be a mere bony splint bound into the investing membrane of the first soft ray.
• Scale counts: The scales of most fishes have either a smooth exposed surface (cycloid scales) or a minutely denticulated surface (ctenoid scales) which is rough to the feel; the denticulations can be seen with a lens. In general the maximum possible scale count is stated (including small interpolated scales in the lateral line and scales of reduced size near the origins of vertical fins), but not including scales of fin bases or sheathes.
Scale formulae are often written thus.

• Indicating the lateral line count and the scales above and below it.