Fig. 6. Shoulder-girdles of
Notornis (thick even line).
Tribonyx (thin ,, ,,).
Ocydromus (dotted line).
Porphyrio (broken ,,).
All drawn to a common length of trunk.
cr, *cr'*, *cr''*, *cr'''*, ventral ends of coracoids.
sc, *sc'*, *sc''*, *sc'''*, distal ends of scapulæ.

Fig. 7. Furculæ of
A. *Porphyrio.*
B. *Tribonyx.*
C. *Notornis.*
D. *Ocydromus.*
All two-thirds natural size.

Fig. 8. Outline of pelvis of *Notornis* (even line) with that of *Ocydromus* superposed on the left side (dotted line), and that of *Porphyrio* on the right (broken line).

Fig. 8A. Outline of left half of pelvis of *Notornis* (even line) and *Tribonyx* (dotted line).
All drawn to a common length of sacrum and viewed from the dorsal aspect.
xy, long axis of sacrum.
il, ilium (præ-acetabular portion).
il', ,, (post- ,, ,,).
is, *is'*, *is''*, *is'''*, ischium.
pu, *pu'*, *pu''*, *pu'''*, pubis.
sa, sacrum.
(Figs. 3 to 8 from drawings by the author.)

ART. XXXIII.—*On a new Method of preserving Cartilaginous Skeletons and other soft Animal Structures.* By T. JEFFERY PARKER, B.Sc. London, Professor of Biology in the University of Otago.

[*Read before the Otago Institute, 21st June*, 1881.*]

ON reading Professor Miall's account of his method of employing glycerine jelly instead of alcohol for the preservation of anatomical specimens,† it occurred to me that the more solid and less complicated structures might be preserved by thoroughly impregnating them with glycerine jelly and then allowing them to dry. The advantages of such a mode of preservation are obvious, since it allows of the handling of the specimens, and does away with the necessity for containing vessels, and the optical disadvantages of a surrounding medium.

I was able to make very few experiments on the subject before leaving England, but during the whole of the past year I have tested the method

* I have partly re-written this paper so as to include additions and corrections up to the present time, February 18th, 1882.—T.J.P.

† "Nature," vol. xviii., p. 312.

about to be described enough to make me feel tolerably confident in recommending it as of special value in the case of cartilaginous skeletons, and useful for hollow viscera, the exoskeletons of Crustacea and Echinodermata, etc.

It will be advisable to describe separately the chief applications of the method.

1. *Cartilaginous skeletons.* I find the best way to clean the skeletons of fresh Elasmobranchs is to clear away the flesh, etc., very roughly, after removal of the skin and viscera, then to dissect away the gill-arches, and then to plunge the body into boiling water for a few seconds. This softens the muscle and connective tissues so much that their removal is rendered quite easy, while, if prepared in the cold, it is almost impossible to remove the tough perichondrium without injury to the cartilage. In the case of even moderate sized specimens it is often necessary after separating the skull, vertebral column, and fins, to dip each part again into boiling water. With very large specimens it is necessary to separate the different regions of the skeleton, and even to cut the vertebral column into segments before plunging them in the water, as otherwise no ordinary vessel will suffice for their immersion. In the case of spirit specimens parboiling is not necessary. The gill-arches should be thoroughly hardened in spirits and then cleaned by ordinary dissection; even a slight application of heat causes the separation of their delicate cartilages. In the same way no heat must be employed in the preparation of persistent notochords, as for instance in the case of *Callorhynchus*.

When thoroughly cleaned, fresh specimens should be placed in strong methylated spirit for two or three weeks. This hardens the cartilage and produces a certain amount of shrinking. In the case of large skeletons (sharks, etc.), this operation may be dispensed with on economical grounds, but without it the results are never so satisfactory.

When thoroughly hardened the specimen is transferred to one of the following fluids:—

GLYCERINE FLUID, A.	
Glycerine	1 litre.
Water	1 „
Corrosive sublimate ..	10 grams.
Alum	10 „

GLYCERINE FLUID, B.	
Glycerine	1 litre.
Water	1 „
Concentrated solution of Phenol	5 c.c.
Alum	10 grams.

Of the two fluids, B seems to give the best results, the colour of its specimens being better than that of those prepared by A. The alum may be omitted if the specimen has been previously hardened in alcohol. It is always advisable to use earthenware vessels; indeed, this is necessary in the case of A, as corrosive sublimate acts upon metals. It is also a good

plan to have vessels of various sizes, so as not to use more of the fluid than is absolutely necessary. I find that a small pudding basin, a vegetable dish, a soup tureen, and an earthenware foot-bath, or "tongue pan," form a very useful series of vessels. If earthenware vessels of sufficient size cannot be had, tin, zinc, or galvanized iron may be used; but then fluid B must be employed, and not A.

After remaining in the glycerine fluid for about three to seven days, according to size and density, the specimen is transferred to melted glycerine jelly, made in one of the following ways:—

Glycerine Jelly, A.	
Glycerine	1 litre.
Water	1 „
Gelatine	150 grms.
Corrosive sublimate ..	10 „

Glycerine Jelly, B.	
Glycerine	1 litre.
Water	1 „
Gelatine	150 grms.
Concentrated solution of Phenol	5 c.c.

Either of these fluids may of course be made by removing the specimen from the glycerine fluid, dissolving in the latter the requisite quantity of gelatine, and when the jelly is of the right temperature, replacing the specimen. It is not well to have much alum present, as it tends to stiffen the jelly. I generally use gelatine-glue instead of pure gelatine, for the sake of cheapness. Even common glue will answer the purpose, the chief disadvantage attending its use being the darker colour of the specimens.

The jelly must be kept at a temperature just sufficient to retain it in the fluid condition (about 40° C.); for this purpose it is best to use a water-bath. The specimen is retained in it from two to four days, so as to get it thoroughly permeated with glycerine jelly.

After removal from the jelly the specimen is thoroughly drained and placed in a dry room on a sort of trellis-work tray, made by stretching pieces of tape across a wooden frame; this allows of exposure to the air on all sides. The drying-room should be kept shut up as far as possible, so as to keep dust from the sticky surface of the specimen. Such cartilages as the shoulder-girdles and jaws of Elasmobranchs, which are strongly curved and of considerable thickness, should be fastened in position during drying by strappings of tape, wooden supports, etc., as otherwise the small but inevitable shrinking which takes place will cause a certain amount of distortion, and prevent accurate fitting when the whole skeleton is mounted. The gill-arches should be very carefully fixed out in their natural position before drying.

Of wholly cartilaginous skeletons there have been prepared for the Dunedin Museum *Carcharodon*, a young male about 10 feet long, *Cestracion*, *Raja*, and *Trygon*, as well as skulls of *Petromyzon*, *Alopecias*, and *Acanthias*. The first of these was prepared with an insufficient amount of gelatine and is

therefore not a great success; *Raja* was prepared without previous immersion in alcohol, and although a vast improvement on the ordinary skeletons of the same fish, is not so good as one could wish; but *Cestracion* and *Trygon* show, up to the present time, remarkably little alteration, the latter having been removed from glycerine jelly for about six weeks, the former for fully three months.

The success of the method is most marked in purely cartilaginous parts, such as the branchial arches, with their delicate branchial rays, which after many months retain their flexibility and translucence unimpaired. The thicker parts of the skeleton show, naturally, the greatest amount of distortion, and this is particularly marked when there is a thickish superficial layer of calcific matter, as in the jaws, etc., of Elasmobranchs: with these parts, the shrinking of the cartilage always produces a slight cracking of the bony matter, but as a similar though less marked cracking is seen in spirit specimens, I do not see how it is to be altogether obviated, unless, perhaps, by using a larger proportion of glycerine.

It is always advisable to allow the specimens several weeks to dry; when the surface no longer feels sticky they are varnished with a solution of white shellac in rectified spirit, the operation being conducted in a warm dry room, as the slightest damp produces precipitation of the shellac. If properly managed, two or three applications of this varnish produce a dry and smooth but not too glossy surface. *

In mounting skeletons prepared in this way, the best plan is to make a framework of japanned wire, of such a form as to serve as a series of rests, or "cradles," for the several parts; the gills are best supported on a special light wire framework. Unless absolutely necessary, no attempt should be made to fasten parts together with wire as in ordinary articulating, and when this has to be done, neither iron, copper, nor brass wire is admissible; silver or platinum only should be used if "glycerine jelly A" has been employed, with "B," pure tin would probably be safe. The method of mounting recommended has the advantage of allowing each part to be separately removed for examination; this of course adds greatly to the value of the skeleton for teaching purposes.

2. *Partly ossified skeletons.* Of these I have had prepared skeletons of *Ceratodus*, and of fœtal calf and foal, and two skulls of the trout, and hope before long to get examples of the various genera of Ganoids and *Urodela*; the method has also been employed with good results for the mesethmoid

* Some recent experiments seem to show that a better varnish is afforded by a solution of dried Canada balsam in benzol, or by equal parts of undried Canada balsam and solution of gum benzoin in methylated spirit.

of mammalian and other skulls, the sternum and sternal ribs of reptiles and mammals, and other partly or wholly cartilaginous portions of the skeleton of the higher animals.

The skeleton of *Ceratodus* was prepared from a specimen which had been for a long time in alcohol; when cleaned it was put through the process described above, as a whole, the cartiliginous and bony portions being too intimately united to allow of the former being prepared alone. This skeleton has now been prepared for upwards of six months, and shows no signs of deterioration. During the whole process it only lost $\frac{1}{36}$ of its length, and even the notochord is hardly more shrunk than in a spirit specimen.

The trouts' skulls were prepared by plunging in boiling water for a few seconds, and then removing the membrane bones; the chondrocranium, Meckel's cartilages and the branchial arches only being put through the glycerine jelly process. After nearly six months the shrinking of the chondrocranium is so slight that the membrane bones fit into their places with almost perfect accuracy. The chief drawback to this preparation is the bad colour taken by the cartilage bones, which of course have to be put through the preserving process; they assume much the colour of the cartilage and cannot be brought to the same state of whiteness as the membrane bones, which are dried at once.

The same objection applies to such parts of the fœtal skeletons, which were put through the preserving process entire. In the case of long bones, the plan was adopted of macerating until the epiphyses could be easily removed, and then preparing these latter alone, and afterwards wiring them on to the shafts. After several weeks the shrinking in these is quite unnoticeable.

3. *Internal organs.* The method has been tried for the hearts of the skate, dogfish, and leopard-seal, the stomach and intestine of the skate, and brains of the skate and sheep. All such structures are first thoroughly hardened in alcohol or chromic acid, and are then subjected to the same process as the cartilaginous skeletons, care being taken to support them carefully in the desired position while drying: veins, for instance, have to be kept open with cylinders of card-board, and so on. It is best to make any dissection of these organs after their removal from alcohol, they can, however, be trimmed conveniently when thoroughly dry. As a rule the thinner organs are more successful than those of considerable thickness; the intestine of the skate, for instance, with the spiral valve displayed, shows no perceptible shrinking: while the ventricles of the seal's heart are perceptibly thinner than before drying; none of the details of structure, however, being lost. These organs, like the bones, assume a dark colour, and are not very attractive as preparations: they are, however, greatly

improved both in appearance and in usefulness for museum and lecture purposes by being painted and varnished—the hearts, *e.g.*, receive the conventional blue and red hues. Distemper colours mixed with a solution of shellac in methylated spirit seem to answer very well.

For brains, my present experience seems to show that my method is inferior to Giacomini's,* but the number of experiments made is hardly sufficient to justify a very positive opinion. Anyhow, I do not expect to effect much improvement in this particular direction; the series of brains prepared by my colleague Dr. Scott, by Giacomini's method, could not easily be bettered.

4. *Invertebrate exoskeletons.* A modification of the above method appears to be very useful for Crustacea, Echinodermata, and other invertebrates with hard exoskeletons. The internal organs are first, as far as possible, removed, and the specimens are then placed in glycerine fluid for a few days; they are then well drained, and after a few days dipped into thin size, kept as nearly as possible at the ordinary temperature of the air: this is done two or three times, and has the effect of producing a good surface; a coat of varnish may afterwards be applied or not according to circumstances. For the larger Crustacea this method appears to be very successful; the chitinous parts retain their flexibility, so that the risk of injury to the specimen is greatly diminished, and the natural colours are retained, in many cases, perfectly. A female *Halimus hectori*, for instance, with eggs attached to the swimmerets, has the general dark colour of the body unaltered, instead of being nearly colourless as in ordinary dried specimens, and the bright scarlet eggs have merely become a shade or two darker, their form and translucence being unchanged.†

5. *Skins of fishes, amphibia, etc.* From one or two experiments, I think the method described in the preceding paragraph is likely to prove very useful for the preparation of skins of fishes, etc., for stuffing. The glycerine fluid must, however, be of only half the usual strength, *i.e.*, one part of glycerine to two of water. The fish is skinned while perfectly fresh, and the skin prepared as above and then stuffed. Some of the colours appear to be retained very well by this method, but I have not yet succeeded in retaining the more delicate shades, such as the spots of the trout and the pink tints of the red cod (*Lotella bacchus*). There is certainly one great

* Journ. of Anat. and Phys., Jan., 1879.

† I believe that my friend Professor Haddon, when curator of the Cambridge Museum, employed glycerine for preserving Crustacea, but I know nothing of the way in which it was used. In Dr. Carpenter's fine collection of starfish, the colours are beautifully preserved by means of glycerine, but the specimens are enclosed in glass cells, which are expensive and troublesome.

advantage in the method, namely, that it diminishes greatly the shrinking of the fins and other thin parts: adipose fins, for instance, retain their form very satisfactorily. It is possible that the same method, or some modification of it, may be applicable to the preservation of the wattles and other soft parts of birds.

It will be obvious from what has been said that the glycerine jelly process of preserving animal structures is slow, troublesome, and expensive. It will, therefore, probably never be very widely used, although the simplified modification of it described in section 4 should, I think, quite supersede the ordinary method of merely drying the specimens. But even the more complicated process is well worth the trouble it gives if it provides the museum or the zoological laboratory with a small series of type-skeletons of Elasmobranchs, Ganoids, Amphibia, etc., which can be handled like ordinary skeletons, and at the same time have their form almost unaltered, instead of being either in the form of spirit specimens or in that of the shapeless and brittle abominations which usually do duty for the skeletons of cartilaginous fishes.

In conclusion it is only right to mention that the success of my experiments is largely due to the skill and intelligence of my assistants, Messrs. Jennings and Bourne.

ART. XXXIV.—*Notice of the Occurrence of the Eastern Golden Plover* (Charadrius fulvus) *in the Auckland District.* By T. F. CHEESEMAN, F.L.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 13th June*, 1881.]

FEW birds have a wider geographical range than the Eastern Golden Plover *(Charadrius fulvus)*. Drs. Finsch and Hartlaub, in their work on the avifauna of Central Polynesia, give an excellent sketch of its distribution. According to them, it ranges along the whole of the eastern shores of Asia, from Northern Siberia and Kamtschatka through Japan and China to the Malay Archipelago and India. Eastwards and southwards, it extends to New Guinea, Australia, and Tasmania, and has been recorded from almost every group of islands in Polynesia. Its breeding quarters, however, are confined to Northern Asia, and it thus exists as a migrant only in countries to the south of China.

The Golden Plover was first recorded from New Zealand by the late Mr. G. R. Gray (under the name of *C. xanthocheilus*, Wagl.), in his catalogue of the birds of New Zealand, printed in vol. ii. of Dieffenbach's "New Zealand,"