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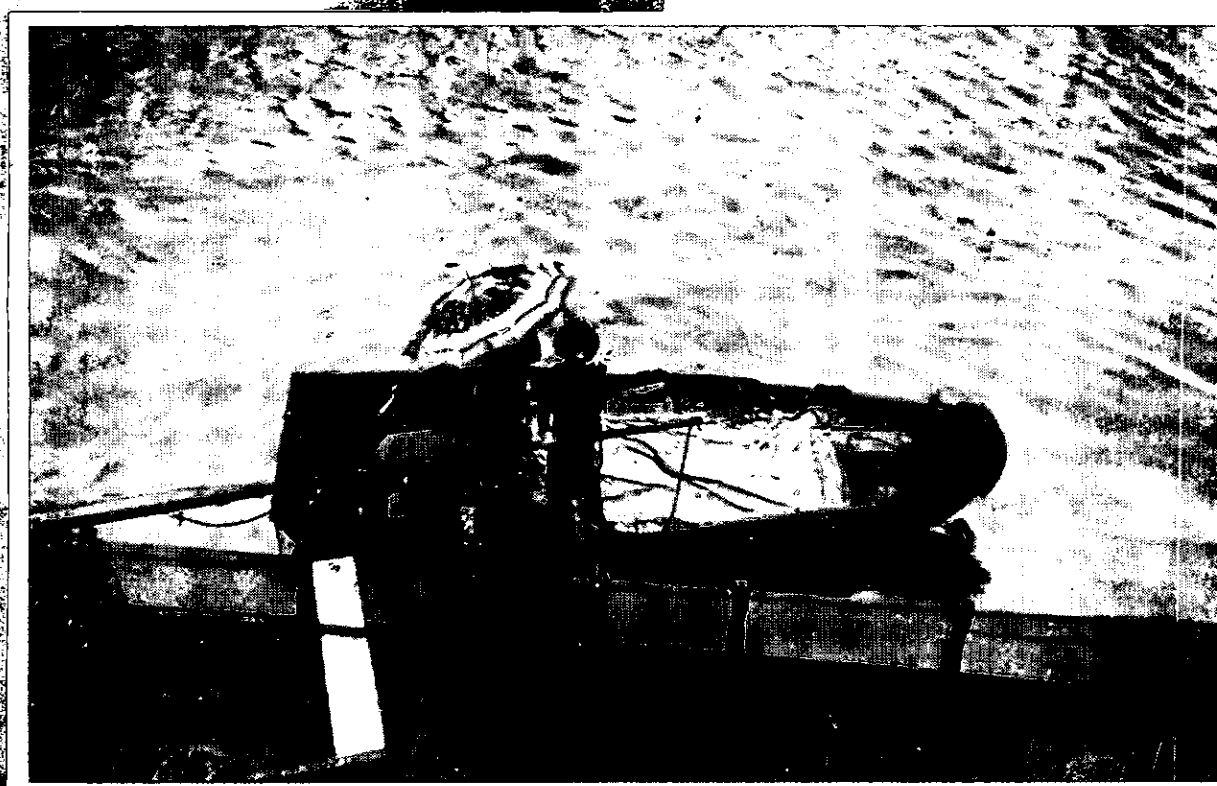

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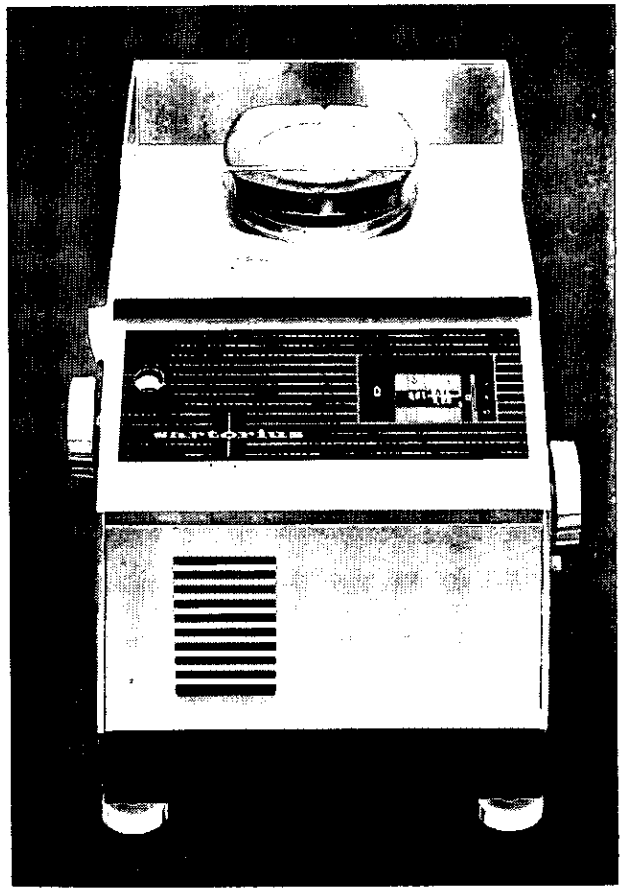

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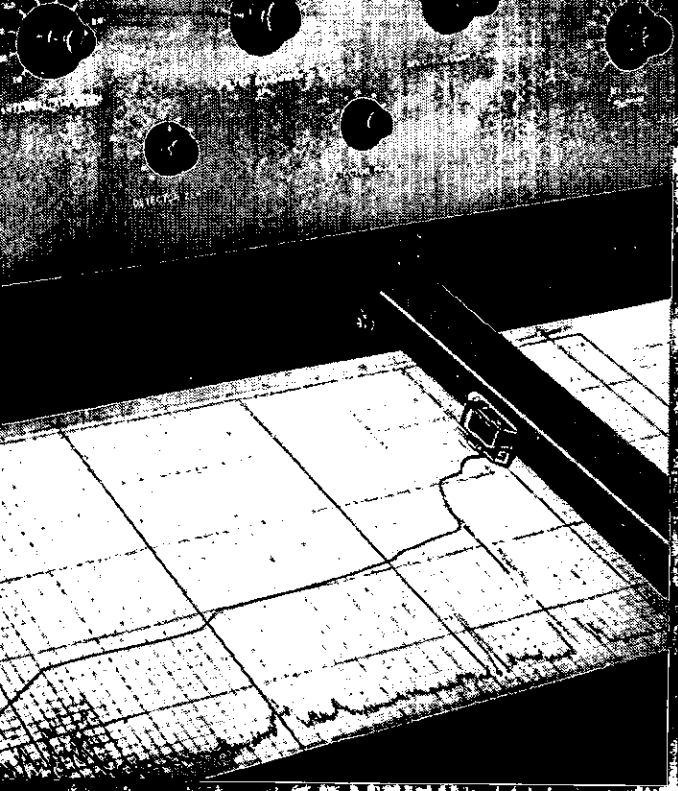

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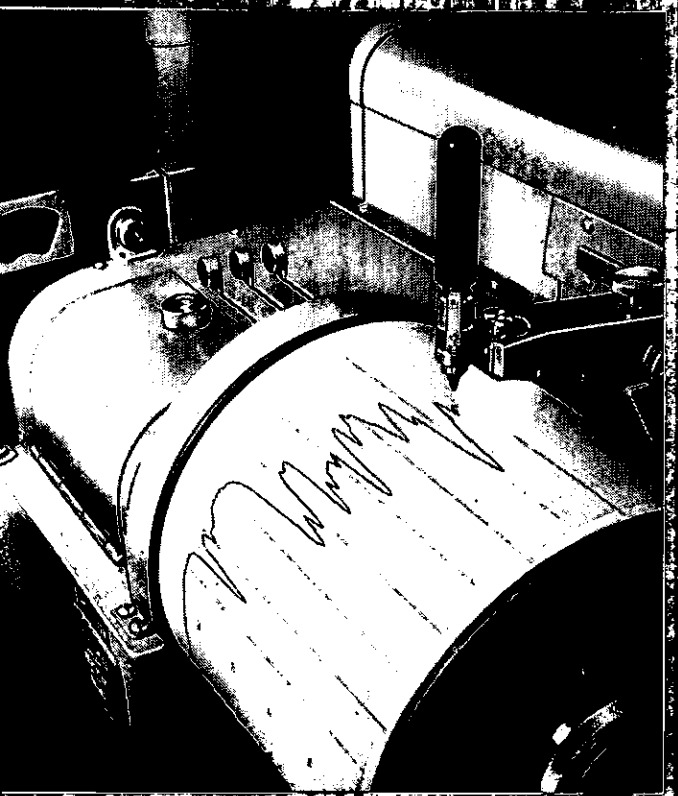

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THE VERTEBRATE PITUITARY NEURO-HORMONES

W. G. Whittlestone, D.Sc., F.N.Z.I.C., Ruakura Agricultural Research Centre, Hamilton

Someone once described the pituitary gland as the "conductor of the endocrine orchestra". This is very apt as this small organ manufactures the "trophic" hormones which regulate the function of several other endocrine organs. However, it is not autonomous; it is regulated by the level of the different hormones in the blood stream, forming part of a negative feed-back loop in some cases. It is also regulated in some way by the nervous system. This fact is curious as there are no known secretory nerves supplying the anterior pituitary, the portion which makes the "trophic" hormones. Some chemical control must intervene between the nervous system and the anterior pituitary. Figure 1 shows that the anterior pituitary (pars distalis) is connected by blood vessels (portal vessels) to the pars tuberalis which is really part of the neurohypophysis of which the posterior lobe or processus infundibularis forms a part.

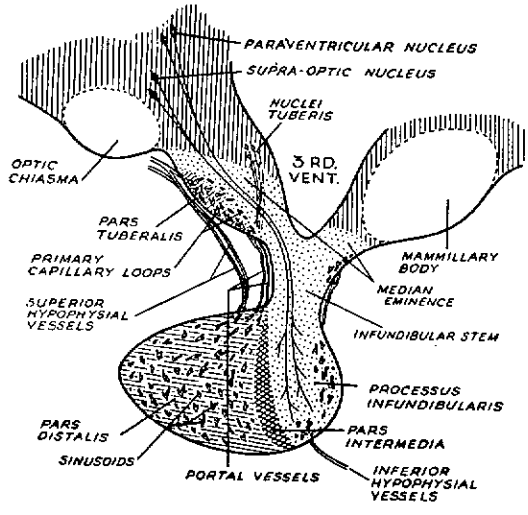
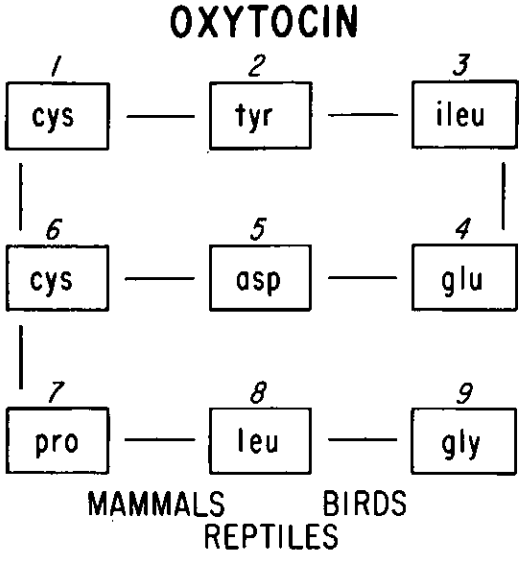


Figure 1

There is now good evidence that hormones synthesised in the brain migrate down the pituitary stalk (infundibular stem) and are stored in the posterior lobe and in the pars tuberalis. On release following nervous stimulation these substances pass via the portal circulation into the anterior lobe (pars distalis) where they influence the release of the hormones made and stored by this organ.

The figure shows the way the pituitary gland is connected to the base of the brain by the infundibular stem. The stem is really an outgrowth of the brain intimately in contact with the pars intermedia and the anterior lobe which in the embryo grows up from the tissue of the roof of the mouth. This structure would appear to be the link between the two great controlling systems of the mammalian body—the nervous and the endocrine systems.

The ejection of milk from the mammary gland is brought about by the hormone oxytocin which may be regarded as a classical example of a neuro-secretion.[1] This is one of two similar peptides which are secreted within the nucleus supraopticus and the nucleus paraventricularis of the hypothalamus, transported down the nerve axons which make up most of the pituitary stalk, and stored in the posterior portion of the pituitary gland.[2] The structure of oxytocin, a cyclic peptide, is shown in Fig. 2. In all cases so far studied, milk ejection is associated with an antidiuretic action taking place at the loop of Henle of the kidney. This is brought about by the peptide arginine vasopressin,[3] whose structure is shown in Fig. 3. This molecule has phenylalanine in position 3 and arginine in position 8. Seven cyclic peptides are now known to be present throughout the vertebrate phylum,



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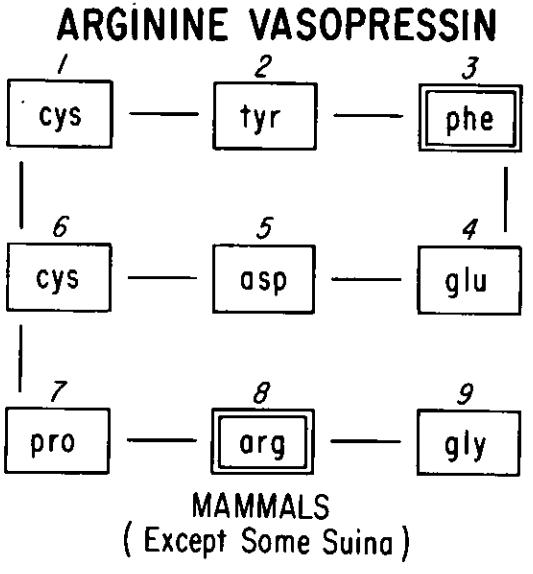

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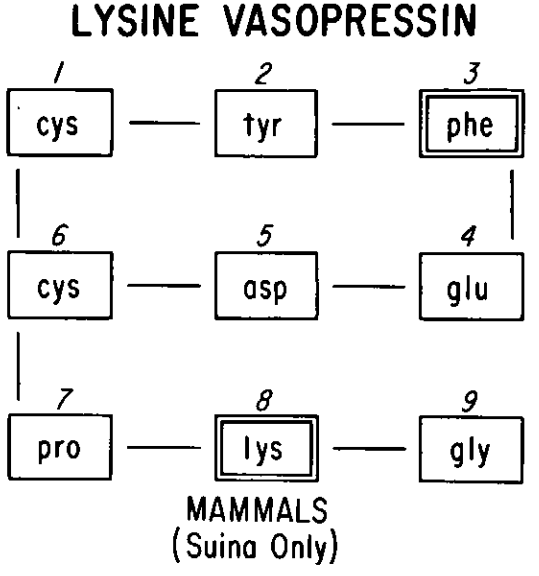

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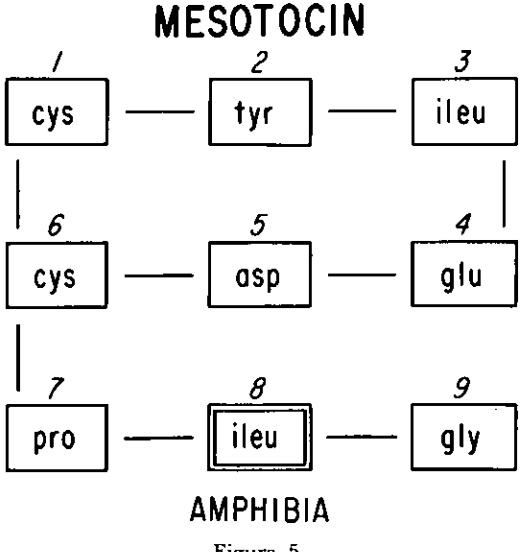

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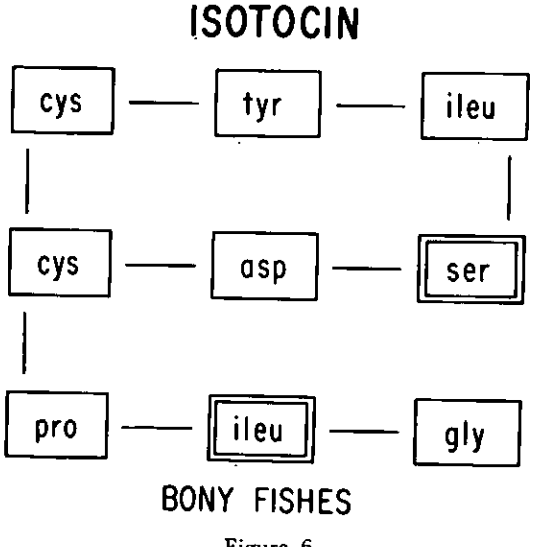

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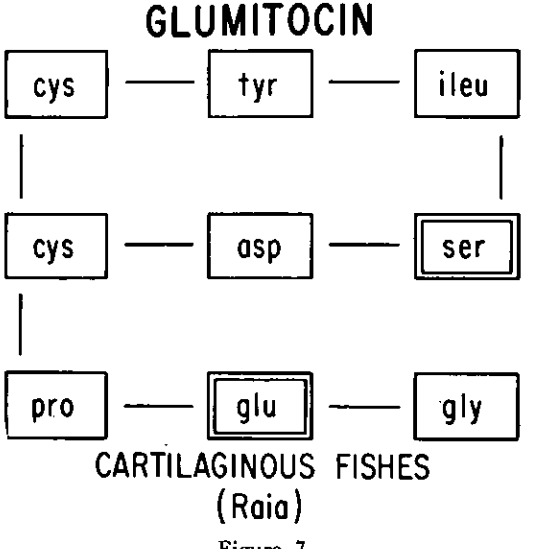

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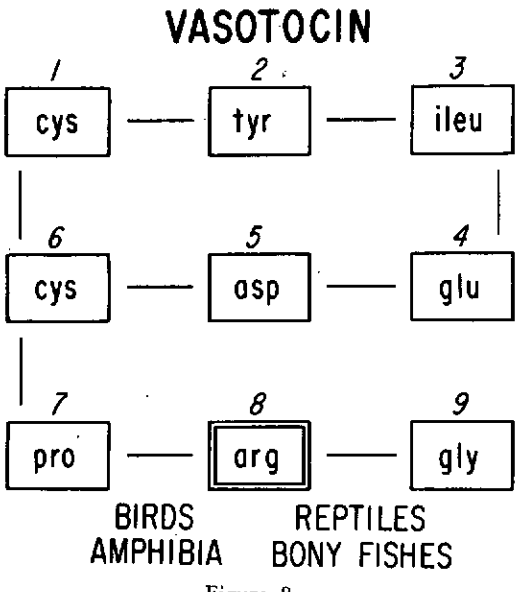

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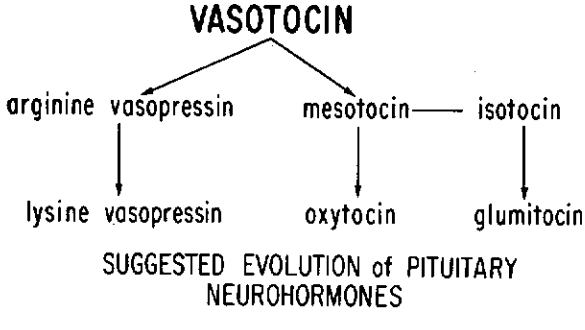

Figure 9

all of them being associated with the hypothalamus and the pituitary. The structures of the remaining five of these are set out in Figs. 4, 5, 6, 7 and 8.[4,5]

It is interesting to speculate on a possible scheme for the evolutionary changes which may have taken place in the development of these hormones. Fig. 9 sets out at highly speculative scheme based on the assumption that only one aminoacid change would take place per mutation. It is extremely interesting to note that all the vertebrates examined so far have two cyclic peptides in the neurohypophysis, with the exception of the cyclostome fish which appear to have descended directly from archaic ancestors. The cyclostomes contain only arginine vasotocin. A summary of our knowledge of the distribution of the pituitary neuro-hormones is given in Table I. In the mammals, arginine and lysine vasopressins regulate the osmotic pressure of the blood while oxytocin is responsible for controlling the ejection of milk and for bringing about uterine contractions during parturition. In general, the vasopressin-like hormones, which are more basic than the oxytocin-like compounds, regulate osmotic pressure throughout the vertebrate phylum, while the oxytocin-like substances appear to be responsible for controlling reproduction.[6,7]

The type of chemical change which has taken place in the transition from vasotocin to the vasopressins is shown in Fig. 10. The

TABLE 1

FISHES: bony	isotocin	vasotocin
: cartilaginous (Raia)	glumitocin	vasotocin
: lung fish	oxytocin	mesotocin
AMPHIBIA	mesotocin	vasotocin
(Leopard frog, R. pipiens)	oxytocin	vasotocin
BIRDS	oxytocin	vasotocin
REPTILES	oxytocin	vasotocin
Western diamond-backed rattle-snake, C. atrox	mesotocin	vasotocin
MAMMALS	oxytocin	arginine vasopressin (AVP)
Suina	oxytocin	lysine vasopressin (LVP)
(Peccaries and warthogs have both AVP and LVP)[28]		

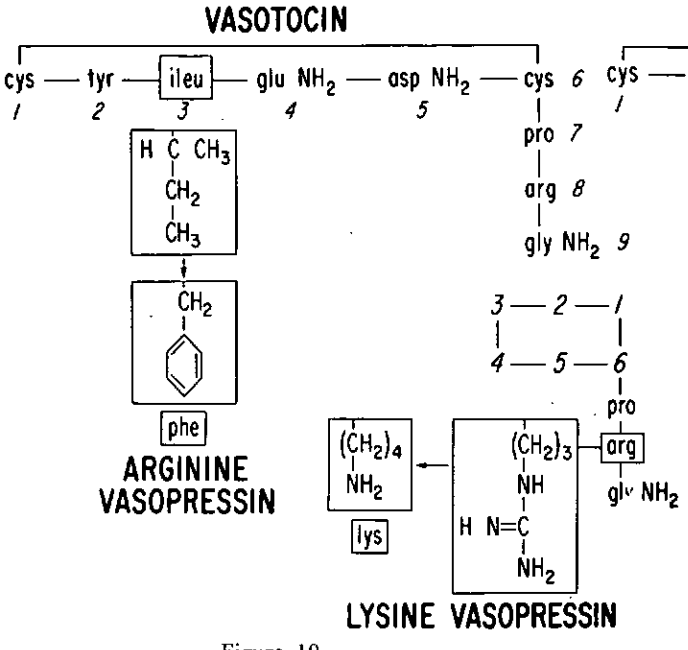

Figure 10

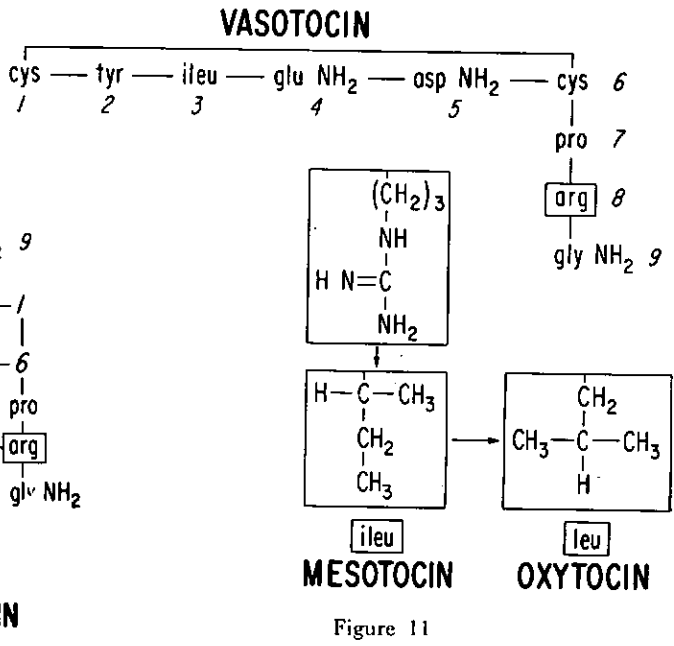

Figure 11

change within the ring from isoleucine to phenylalanine is quite dramatic chemically and represents a large change in pharmacological properties. On the other hand, the change in the side chain from arginine to lysine is not nearly so dramatic, and in fact for many years lysine vasopressin was not distinguishable from arginine vasopressin. Both are extracted from pituitaries in the preparation of posterior lobe extract. When pig glands are used for the preparation, lysine vasopressin is the active ingredient, while sheep or cattle glands contain arginine vasopressin. In this connection it is interesting to note that not all of the pig family contain lysine vasopressin only. The peccaries and warthogs may have arginine or lysine or both, suggesting that the mutation from arginine to lysine produced such a small change in physiological characteristics that it had no effect on the evolution of these animals. Fig. 11 sets out the chemical transitions involved in going from vasotocin through mesotocin to oxytocin. The replacement of arginine in the side chain by isoleucine represents a big change in chemical properties because of the highly basic nature of the arginine molecule. On the other hand, the transition from isoleucine to leucine brings about a very small change in the chemistry of the peptide. Fig. 12 shows a scheme of transition from mesotocin to isotocin and glumitocin. The transition from glutamine in the ring to serine represents a substantial chemical change, as does the transition from isoleucine to glutamine in the side chain.

The importance of this field of chemistry for biology at the moment lies to a large extent in the fact that it may throw a lot of light on certain evolutionary changes. Imagine a mutation that causes a single amino acid change in a pituitary peptide. This could result in a switching of the target organ from, say, the skin of an amphibian [whose water balance mechanism depends on the neuro-hormone acting on the permeability of the skin] to the loop of Henle of its kidney. This would make possible the transition from amphibian life, which is largely dependant upon a water environment, to permanent life on dry land. As our understanding of the

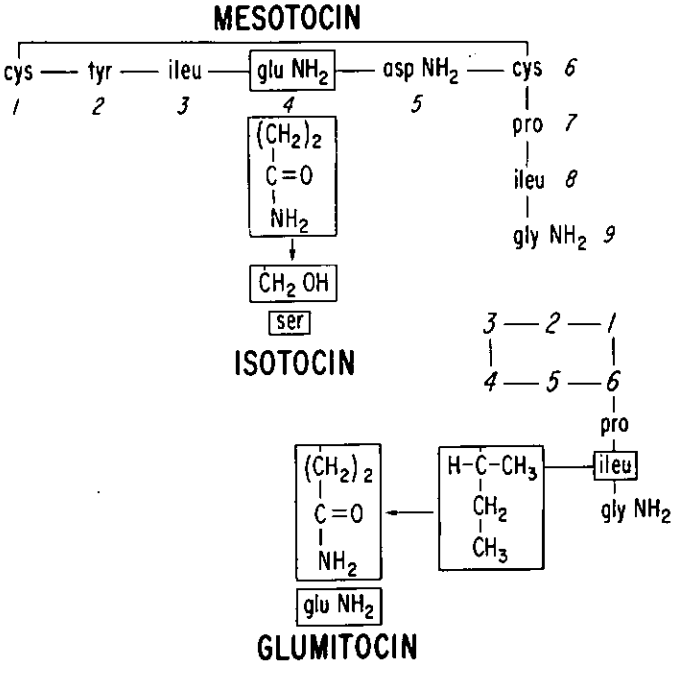

Figure 12

distribution of these hormones increases and their physiological properties become more widely known it seems very likely that some important contributions to the theory of evolution will emerge.

In passing, it is interesting to note that the production of oxytocin and vasopressin in the mammal are under separate genetic control. A mutation has appeared in rats resulting in congenital diabetes insipidus. The diabetic rats contain no vasopressin whatever in their pituitaries, while the oxytocin concentration, although reduced, is quite adequate. The heterozygotes have a vasopressin level of about two-thirds normal and the oxytocin level is normal.[8]

In the mammals which have been investigated the two pituitary peptides are associated with a protein in the neuro-hypophysis.[9] In the bovine this protein has a molecular weight of 25,000 and is associated with seven molecules of oxytocin and four of arginine vasopressin. It seems likely that the release of the peptides into the blood stream is dependent on some mechanism which frees the peptides from the protein molecule whose size is such that it is unable to diffuse into the nearby blood vessels. The pituicyte cells of the posterior lobe[10] have been suggested as providing a mechanism for the release of the peptide from the protein complex. In the guinea pig these cells increase in numbers and activity during lactation when oxytocin plays an important part.

Both vasopressin and oxytocin are released during milk ejection.[12] The latter however may be regarded as the milk ejection hormone as it has five times the activity of vasopressin when assayed using the milk ejection response of the sow[13] or the rabbit[14] as a measure of activity. Oxytocin has been detected in the jugular blood of cows and sows following machine milking and suckling respectively. It has occasionally, but not always, been detected in the blood of goats during hand milking. This species is interesting in that it would appear to be able to release its milk after secretion without the ejection reflex which normally results in the release of oxytocin following the tactile and thermal stimuli associated with the suckling of the young.[15,16] However, there is some evidence that baroreceptors within the gland duct system may play a role also in initiating the milk ejection mechanism.[17] Once released into the blood stream oxytocin is quickly removed[16,18] The half-life in a number of animals has been estimated.[19] A figure of 1 minute 14 seconds has been given for the goat, 1 minute to 1 minute 35 seconds for the cow and between 1 minute 12 seconds and 4 minutes for women. The hormone is taken rapidly from the blood stream by the kidney, the liver and the uterus (under certain conditions). In women, who may lactate during pregnancy, the enzyme oxytocinase brings about a rapid destruction towards the end of term.[19] As indicated earlier, the target organs for oxytocin are the uterus and the mammary myoepithelium.[20] The latter is more specific in its response to oxytocin than the former, so is the basis for several of the best biological assays. Because of the extremely low concen-

trations involved in these physiological processes, no known chemical method will detect the presence of oxytocin. It is interesting to note that the mammary myoepthelial cells may be made to contract by tap or mechanical stimuli.[21] It is thus possible that the very vigorous suckling action of many mammals may result in an immediate contraction of the myoepithelium before the milk ejection response involving oxytocin has had time to take place.

The milk ejection mechanism may be inhibited by unusual stimuli.[22] This is a central or Pavlovian type of inhibition. Another and not uncommon inhibition results from the release of adrenalin[23] caused by fear or fright —a phenomenon not unknown in the cow shed!

In addition to their role as hormones acting on peripheral target organs, the pituitary neuro-hormones have been implicated in the control of the release of anterior pituitary hormones. The pituitary portal circulation contains primary capillary loops in the part of the neuro-hypophysis called the median eminence. These loops may take up hormone and transmit it via the portal vessels to the secondary capillary loops dispersed throughout the anterior pituitary. The suckling stimulus is known to be important in the maintenance of milk secretion as is the anterior pituitary hormone prolactin. It has therefore been suggested[23,25] that the release of oxytocin by the neuro-hypophysis causes, as a result of the passage of this hormone through the pituitary portal circulation, the release of anterior lobe prolactin which in turn acts on the mammary gland to stimulate secretion. Evidence for the role of oxytocin in the control of the release of prolactin is by no means entirely satisfactory. There is also evidence that the effect of oxytocin in the mammary gland itself may result in increased local circulation of blood and so an increase in the overall milk secretion rate.[26] It is not impossible that both effects are important.

The point of general interest about the possible role of the pituitary neuro-hormones as links between the neuro-hypophysis and the anterior pituitary is the fact that there is no known neural control of the anterior pituitary gland. This means that any communication between the central nervous system and the controlling centre of the endocrines, the anterior pituitary, must be of a vascular nature. Because of the anatomical relationships between the primary and the secondary loops of the pituitary portal system it is natural to assume that the pituitary neuro-hormones play some role in the regulation of the anterior-pituitary. If this proves to be so, it will be an example of another interesting generalisation, that when the central nervous system communicates with the endocrines it does so via a neurosecretion, that is, a hormone produced within a nerve cell which is functionally connected to the central nervous system but acts also as an endocrine organ. Thus, milk ejection may be regarded as a classical example of a reflex involving a neuro-secretion. Hypothalamic neuro-secretory neurones generate a hormone which is discharged into the blood stream via a neurohaemal organ, the posterior pituitary, thus functionally connecting the peripheral target organ, the mammary gland, with the central nervous system.[27]

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Review . . .

PRACTICAL APPLICATIONS OF ION EXCHANGE RESINS IN INORGANIC CHEMISTRY

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Ion exchange resins are used in many industrial purification processes on a large scale, but apart from the production of "deionised water" in the laboratory, they appear to be a rather neglected research tool. In this review, a selection of the more recent practical applications of ion exchange resins to research and analytical problems in inorganic chemistry will be discussed.

The Resin Material

Analytical grade ion exchange resins can now be obtained in a high state of purity and in a variety of particle sizes. Both cation and anion forms of the best material are almost white in colour, which enables the separation of coloured bands to be observed visually. The resin characteristics are usually well described in the manufacturers' manuals[1,2,3] and will not be discussed here. Two features that are not usually mentioned are "colour throw" and resin swelling. The former is most serious when spectrophotometric analyses of the effluents are to be made and results from the breakdown of cation resins in the hydrogen form to red or yellow, high molecular weight sulphonates. Consequently the resin material must be thoroughly washed with distilled water prior to use and, once a column has been prepared, prewashed with the strongest acid to be used for elution.

Low crossed linked resins have a tendency to shrink when treated with high ionic concentrations and swell again when washed with more dilute solutions. As a result, care must be taken to avoid tightly packed columns or the tube walls may rupture.

The Ion Exchange Column

Figure 1 illustrates a typical jacketed ion exchange column which can be used with compressed air or a gravity flow. A slurry of resin in water is placed in the column, using a pipette with the tip removed, and allowed to settle under gravity. The water is drained to the top of the resin and the

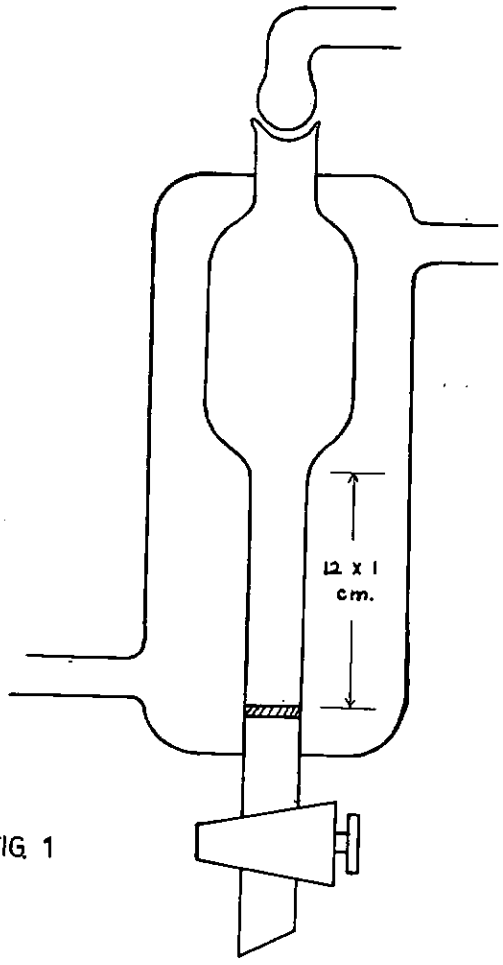

FIG. 1

column is ready to be charged with an exchange solution or for prewashing with an eluting agent. Compressed air can be used to facilitate the washing procedures, but for ion exchange chromatography, slow flow rates of eluting agent (1-5 ml/min) are essential for good separation of ion mixtures.

Cation-anion Separation

These separations are based on the fact that only anions are absorbed on anion exchange resins and only cations on cation resins. The counter ions flow directly through the resin column without absorption. Several recent applications of this technique have been used for product analysis of reaction aliquots in kinetic studies.

For the kinetic study[4] of the reaction

$$Cr(NH_3)_5F^{2+} + OH^- = Cr(NH_3)_5OH^{2+} + F^-$$

the extent of the reaction was measured by taking aliquots at known time intervals and analysing for liberated fluoride ion. The aliquots were quenched by cooling and were passed through cation exchange columns in the Na^+ form. The unreacted $Cr(NH_3)_5F^{2+}$ and the $Cr(NH_3)_5OH^{2+}$ product were absorbed and the free fluoride ion (together with released Na^+ from the resin) were obtained in the effluent. The fluoride ion concentration was then determined by conventional means. The separation was necessary as the reagents used to determine fluoride ion also reacted with the coordinated fluoride in the unreacted complex.

Cation Separation — Ions with Different Charges

The separation of cation mixtures of ions with different charges is one of the easiest ion exchange chromatography techniques because of the large difference in resin absorption of $+1$, $+2$ and $+3$ charged ions.

Thus when 1,2,3-Cr(dien)Cl_3 (200 mgm) (dien = $NH_2(CH_2)_2NH(CH_2)_2NH_2$) was dissolved in dilute $HClO_4$ (30 ml, 0.05 M), a mixture of the 1,2,3-Cr(dien)$(OH_2)Cl_2^+$, 1,2,3-Cr(dien)$(OH_2)_2Cl^{2+}$ and 1,2,3-Cr(dien)$(OH_2)_3^{3+}$ cations was formed. This mixture was absorbed on a cation exchange resin (10 × 1 cm) in the H^+ form and eluted successively with 0.6, 2 and 3 M $HClO_4$ (100 ml) to give a clean separation of the $+1$, $+2$ and $+3$ complex ions[5].

In general, $+1$ ions (at a concentration of 1-10 mM) can be effectively eluted with reasonable volumes (50-100 ml) of 0.1-0.6 M H^+, $+2$ ions with 1.2-1.8 M H^+ and $+3$ ions with 2.5-3.5 M H^+.

This technique has also been applied to the separation of an impure reaction product into its constituent components. When the chromium(IV) diperoxo complex Cr(pn)$(OH_2)(O_2)_2.H_2O$ was reacted with con-

centrated HCl and the solution evaporated to dryness, an impure purple solid was obtained, containing several Cr(III) complexes. This solid was dissolved in 0.01 M $HClO_4$ and charged on a cation exchange column (H^+ form) forming a blue-green band and a green effluent solution. The green effluent was passed down an anion resin column (NO_3^- form) and again a green effluent was formed. Analysis of this effluent showed the species in solution to be $Cr(pn)(OH_2)Cl_3$, a non-electrolyte as expected from its ion exchange behaviour.

Elution of the blue-green band on the cation exchange column with 0.03, 0.3 and 3 M $HClO_4$ gave $Cr(OH_2)_4Cl_2^+$, $Cr(pn)(OH_2)_2Cl_2^+$ and $Cr(pn)(OH_2)_3Cl^{2+}$ respectively in the effluents[6].

Ions with Similar Charges

Separation in these systems is more difficult than in those with dissimilar charges and requires very slow flow rates for the eluting agents. This is illustrated by the work of Hughes, Garner and Ebsworth[7] who have separated the Cr(III) ions $Cr(OH_2)_6^{3+}$, $Cr(NH_3)(OH_2)_5^{3+}$, $Cr(NH_3)_2(OH_2)_4^{3+}$ and $Cr(NH_3)_3(OH_2)_3^{3+}$ which were generated in solution by the decomposition of $Cr(NH_3)_3(O_2)_2$ (0.2 g) in $HClO_4$ (50 ml, 1 M). The cation mixture was absorbed on an H^+ resin column and the resin with the absorbed cations was transferred to the top of a 25 × 1 cm H^+ resin column. Elution was effected with a solution of 1.5 M $Ca(ClO_4)_2$ in 1.5 M $HClO_4$, with a flow rate of 1 ml per min. Six hundred and fifty ml eluted the $Cr(OH_2)_6^{3+}$ ion (1.3 mM), 250 ml the $Cr(NH_3)(OH_2)_5^{3+}$ ion (1.3 mM), 250 ml the $Cr(NH_3)(OH_2)_5^{3+}$ ion (1.7 mM), 250 ml the $Cr(NH_3)_2(OH_2)_4^{3+}$ ion (2.0 mM) and a final 250 ml eluted the $Cr(NH_3)_3(OH_2)_3^{3+}$ ion (3.7 mM).

Isomer Separation

It now seems well established experimentally that in $M(en)_2X_2^+$ (en = $NH_2(CH_2)_2NH_2$) (M = Co, Cr; X = acido ligand) systems the *trans* isomers can be removed from cation exchange resins with similar volumes of more dilute eluting agents than their *cis* analogues. Attempts to quantitatively separate the *cis* and *trans* $Cr(en)_2Cl_2^+$ ions have not been completely successful because of the liability of the chloride ion in these systems giving decomposition products during the elution process. However, the less labile *cis* and *trans* $Cr(OH_2)_4Cl_2^+$ ions have been separated using an 8ft long cation exchange column at 3-5° with 0.1 M $HClO_4$ as the eluting agent[8].

In the case of the $Cr(NH_3)_3(OH_2)Cl_2^+$ ion, the ion exchange behaviour has been used to support the assignment of a *trans* dichloro configuration[9].

Syntheses

Syntheses involving the use of ion exchange resins are rather uncommon because of the large volumes of solution used and rather small concentration of product obtained. One recent application is the synthesis of $Na[Cr(en)F_4]$[10]. The double salt $[Cr(en)_2F_2][Cr(en)F_4].H_2O$ (1 g), prepared by reacting CrF_3 with ethylenediamine, was dissolved in water (15 ml) and the solution passed through a cation exchange column in the Na^+ form. The $Cr(en)_2F_2^+$ ion was held on the column, and the blue effluent and one column of wash solution (H_2O) were poured into 150 ml of acetone. A blue precipitate of $Na[Cr(en)F_4].H_2O$ (0.3 g) was obtained.

The conversion of chloro complexes of Co(III) and Cr(III) to hydroxo complexes has also been achieved using ion exchange resins. The aqueous solution of, say, $[Co(NH_3)_5Cl]Cl_2$ was passed down an anion resin column in the OH^- form. Under these conditions the coordinated chloride was rapidly and quantitatively hydrolysed and replaced by the coordinated OH^- group. The free chloride was absorbed on the resin releasing hydroxide ion. Addition of the salt of an appropriate anion, e.g. $NaClO_4$, to the effluent and evaporation of the solution produced crystalline $[Co(NH_3)_5OH](ClO_4)_2$[11].

In the preparation of the 1,2,6-$Cr(NH_3)_3(OH_2)_3^{3+}$ cation[9], a solution of the *trans* dichloro *trans* triammine $Cr(NH_3)_3(OH_2)Cl_2^+$ ion was absorbed on a cation resin in the H^+ form. The column was washed with water until the pH of the effluent was above 6 and then 0.2 M NaOH was run through. This treatment hydrolysed the coordinated ligands of the abosrbed cation and formed $Cr(NH_3)_3(OH)_3$, a non-electrolyte, which was collected in the effluent. Acidification of this basic solution with $HClO_4$ gave the 1,2,6-$Cr(NH_3)_3(OH_2)_3^{3+}$ cation in solution.

The most common synthesis of unusual inorganic acids involves treatment of the barium salt with H_2SO_4 and filtration from the precipitated $BaSO_4$. Such solutions, or even crystalline solids, can be obtained using cation exchange resins in the H^+ form. Thus red crystals of $H[Cr(NH_3)_2(NCS)_4]$ were obtained by passing an aqueous solution of Reinecke's salt, $NH_4[Cr(NH_3)_2(NCS)_4].H_2O$, through an H^+ resin column and evaporation of the effluent solution[12].

Analyses [13]

The equivalent weights of non-labile complex ions can be determined using the technique based upon the quantitative exchange stoichiometry when the cations are absorbed on an H^+ resin. The concentration of released H^+ ions is equivalent to the concentration of the adsorbed cation. Thus, the equivalent weight of *trans*-$[Co(en)_2(NO_2)_2](NO_3)$ was determined[14] by dissolving a weighed amount of the salt in water and passing the solution through an H^+ resin column that had been prewashed with distilled water until a neutral effluent was obtained. The acid effluent from the adsorbed complex cation was titrated with standard NaOH solution and the equivalent weight calculated from the formula, equivalent weight = wt. of complex taken/no. of moles of OH^- required. In this case, the equivalent weight equals the formula weight, and in general for cations of charge N, the formula weight equals the equivalent weight times N.

Analysis of non-specific ions is also readily performed using ion exchange techniques. For example, in the standardisation of sodium perchlorate solution, neither sodium nor perchlorate ions are easily determined quantitatively by direct methods, and $NaClO_4.H_2O$ is unsuitable as a primary standard. Nevertheless, the Na^+ ion concentration in such solutions can be determined by displacement of H^+ by Na^+ on a neutral cation exchange column in the H^+ form. The liberated H^+ ion concentration in the effluent can then be determined by titration with standard NaOH solution.

Neutralisation and Reduction of Ionic Strength at Constant Volume

If 50 ml of 3 M $HClO_4$ and 50 ml of 3 M NaOH solutions are mixed, the resulting neutral solution of 100 ml is 1.5 M in $NaClO_4$. If, however, excess anion resin in the OH^- form is added to the 50 ml of 3 M $HClO_4$ and the resin filtered, the resulting solution is essentially 50 ml of water.

The reaction that takes place is

$$H^+ + ClO_4^- + \underset{\text{(excess)}}{\text{resin(OH)}} = H_2O + \text{resin}(ClO_4)$$

and when the excess resin(OH) and resin (ClO_4) are filtered, ion-free water is produced without appreciable dilution.

This technique has been used in reaction rate studies, particularly where the reacting ion has been isolated by ion exchange chromatography, in low concentration, with a concentrated acid eluting agent. The method of neutralisation allows a reduction in both acidity and ionic strength without dilution, and the reaction rate can be investigated in media other than that provided by the eluting agent[15].

Conclusion

This review has covered only the small selection of ion exchange techniques that have been within the experience of the

author. Amongst other elution techniques that are available, but not discussed here are gradient elution[16], high temperature elution and elution with pH variation[17].

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Technical Topic . . .

REPAIRING MICROLITRE SYRINGES

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Microlitre syringes are prone to blockage when used with relatively viscous biological fluids. Attempts to clear such blockages sometimes result in splitting the barrel, usually in the section near the needle. Syringes are also put out of use with broken needles and bent plungers.

Repair services offered by the manufacturers of microlitre syringes take time and are expensive. Charges are about $6.00 for replacing broken needles or plungers, and split barrels are not repaired.

A simple means of repairing microlitre syringes has been practised successfully in this laboratory. Broken needles can be removed with pliers by carefully rotating them to break the epoxy-resin bond with the barrel. Syringes where the broken needle cannot be removed and syringe barrels with splits can be cut at an appropriate place and the ends ground smooth. Replacement needles can be cut from damaged 5 cm needles or from hypodermic needles which have the required outer diameter. Before cementing the needle the barrel is cleaned with appropriate solvents. An epoxy-resin glue is applied to the needle which is then pushed into the barrel up to a microlitre mark. The glue is set at 55°C after which a plunger can be cut to fit.

Syringes repaired in this way have been found to be quite suitable for G.L.C., notwithstanding that volumes cannot be read off directly. Syringes fitted with hypodermic needles have proved to be more suitable for TLC spotting because the wider bore eliminates creep of liquid up the needle.

LETTER TO THE EDITOR

Dear Editor,

May I comment on two features of the last issue of Chemistry in New Zealand (Vol. 33, No. 1).

(1) Advertisements announcing positions available appearing on pages 28 and 29 mention the closing date February 24, 1969. My issue reached me several days after this date and presumably the notices were of no value by then.

(2) The Guest Editor (need he be anonymouse?) has made a valid point about "outdated" chemists trying to use modern instruments. However, I question the value of *intensive* training in the use of modern instruments for the chemist. Most modern instruments are designed to be efficiently run by well-trained technicians who are supposedly unhampered by the abstractions of chemical thought. I certainly hope the Guest Editor isn't suggesting that we should all be more efficient technicians?

A better policy for New Zealand industry and universities to follow would be to ensure that chemists are given sufficient training in electronics, physics and instrument design so that they are not in awe of "black boxes". In addition, the New Zealand approach toward instruments which don't work (to "have a go" at repairing it straight away) must be restrained. It is then the responsibility of the manufacturers of instruments to provide a *good* manual and prompt servicing by *qualified* personnel (or at least to provide service manuals for local technicians). In my experience, New Zealand scientists are poorly served in these ways by manufacturers.

The fewer "licensed" operators of special instruments the better!

D. B. Myers,
Wellcome Medical Research Institute.

In reply to question (1): Our blocks were caught up in the *Dominion* strike with the unfortunate consequence that the Journal was late.—Ed.

(2) Intensive instrument training was not advocated; only that post-graduate teaching facilities are needed. Technicians with instrumental experience are rare in this country—and again we have the same problem, who teaches the technician?

Dr. Myers' experience with inadequate manuals and service is unfortunately common, but instruments and service are usually bought on the basis of price, not value. More enlightened buying will hopefully engender more enlightened selling.—Guest Editor.

THE PROTEIN PROBLEM: 'GRASSBURGERS' OR MILK BISCUITS? *

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(on Facial Eczema Fellowship, Ruakura Agric. Research Centre, Hamilton)

(Text of talk given to Waikato Branch)

The production of high quality protein foods for human consumption is the main economic interest of New Zealand. The "production" aspect I leave to the scientists at Ruakura; it is known the world over that here are some of the best research experts on animal production. I want to talk about the "consumption" end of the equation, especially in relation to what is said to be the "world protein problem", defined as a shortage of protein foods for the rapidly expanding human population.

Is there a "world protein problem"? The FAO thinks so; they have just published a report with the foreboding title "International Action to Avert the Impending Protein Crisis"[1]. If there is a problem, what kinds of protein products are likely to compete with the classic meat and milk products of New Zealand in solving the problem? Can plant protein concentrates replace animal proteins in nutrition, or must grass be ruminated before effectively used by humans? The two questions to be discussed are, first; a deliniation of the world protein problem, and second; a survey of the protein products available to solve the problem.

A. The World Protein Problem

The population increase. A lot of words have been spoken and written about the population explosion. Experts on the subject have made astounding predictions about the future numbers of people and the increased quantities of food that will be needed to feed them. I won't discuss the predictions because it is easier to talk about facts. One of these facts is that before the end of this year of 1968 the world population will pass 3.5 billion. Just 16 years ago, in 1952, the population of the world was 2.5 billion. This is an increase of 1 billion, or 40 percent, in this short period. What will happen to population numbers in the next few such short periods may depend more on the pill than the pillow. However, the potential for meaningful birth control seems to be totally lacking in most countries. Very likely other forms of biologic control will occur. There are a number of dangerous consequences to unlimited population growth, in addition to starvation and war. Pollution of our environment beyond the liveable stage is a real hazard. Supplies of water may be limiting. A break-down in social services such as education or medical care could lead to mass psychoses and a loss of any humane quality of life.

Food supply. So far, food supply has, on the average, more than matched population growth. Probably at no time in history has man had more food *per capita* per year than he has at the present time. Those who know seem happy about the prospects for world food supply over the next decade or so. They tell us that there has been a revolution in the production of wheat and rice. New management techniques, fertiliser use, and some new high-yield strains—these all indicate that food-grain production in the under-developed countries will increase faster than population for a while. Hopefully, this will give time for these countries to come to grips with human fertility and will allow some increase in the standard of living. The example is given[1]

of the new strain of wheat that has enabled backward Mexico to increase production more than three-fold with little increase in acreage, and to enjoy a better way of living even to the extent of being host to the Olympic games. The Philippines have their new IR-8 strain of rice leading to large increases in yields[2]. Using new wheat and rice strains, India and Pakistan are on the verge of eliminating their food-grain deficit, according to Sir John Crawford[3].

Protein Supply. The extra one billion people that the world has produced over the past 16 years need an extra 55 billion pounds of protein per year. This amount has been produced, including an extra 11 billion pounds of meat protein, eight billion pounds of milk protein and three billion pounds of egg and fish protein[4].

However, the present and increasing food supply of the under-developed countries is based almost entirely on cereal grains. This does little for the protein problem, but if it permits an increased living standard, there will be a demand for better quality protein. Each of these countries will probably accommodate to its protein quality problem by importing food until it can develop its internal supplies. There is no doubt that the firm, long-term policy of every country is self-sufficiency in basic foods. If, in the mean time, the developing country chooses to import the traditional meat and milk protein products, then New Zealand can continue to prosper. Japan is an example of a nation at the quality-food importing stage. However, there are all kinds of alternatives to meat and milk. Some of these will be discussed later.

The protein problem. The protein consumption *per capita* has been maintained near the recommended level of 70 grams per day in spite of the great increase in population over recent years. Why then is there said to be a protein problem? Some FAO data[5] of a few years ago emphasised that it is a matter of distribution:

World Nations	*Protein intake (g/day)*	
	Total	*Animal*
Rich one-third	90	45
Poor two-thirds	58	9

The FAO equates animal protein with good quality, and grain protein with poor quality. This is a useful generalisation that serves to demonstrate the nutritional problems. However it is an approximation that has been converted to a law by constant repetition. I wish I had time to develop the thesis that it is the stage of life, not the kingdom of life, that relates to nutritional protein quality. Embryonic tissues have high quality protein, whether hen's eggs or wheat germ. Metabolic tissue protein such as in beef muscle and plant leaf also have a superior nutritional quality. On the other hand, structural and protective tissue proteins are of poor nutritional quality, whether from plants or animals.

Effects of protein deficiency. The consequences of inadequate protein are very serious for both man and animal; much more is involved than a lowered growth rate. The first danger is to the developing embryo; a recent report[6] showed that rats fed a diet with only 8 percent casein (as contrasted with 27 percent in the control diet), gave birth to young with significantly less protein and with fewer neuronal cells in their brains. Since the number of brain cells does not increase after birth, the brain deficit persisted. The result was adult rats with neurological and behavioural problems, even though presumably fed the control diet after weaning.

Large numbers of human infants suffer from the nutritional disorder variously called protein-calorie deficiency, insufficiency, Kwashiorkor, or Marasmus. The disease develops in the infant after weaning and persists for a number of years. The death rate is high. Among the symptoms of the disease are diarrhoea, muscle wasting, stunted growth, greatly enlarged and damaged liver with extensive haemosiderosis, ascites resulting in the characteristic pot-belly, loss of pigmentation with normally black hair and skin

turning red, intellectual deficiency, and anaemia. There is a drop in the level of serum protein. Disorders are found in the metabolism of several amino acids; however, the disease has not been shown to respond clearly to any one pure aminoacid or to a mixture. It can usually be cured with milk or milk proteins. Some other protein mixtures may have a beneficial effect, although this is not consistently demonstrated.

Another effect of inadequate protein is a lessened resistance to stress, including a greater susceptibility to a variety of liver toxins (in experimental animals).

B. Survey of Protein Products to Solve the Problem

It is apparent that there is a world protein problem. The next question is how best to solve it. What are the food products that might successfully compete with milk and meat? In the following table are listed some of the most likely candidates, with an estimate of their costs on a protein basis. The nutritional qualities of the proteins are expressed by the generally accepted criteria of Protein Efficiency Ratio (or PER). The values are concensus approximations from a variety of sources[7]. I have intentionally omitted some of the more exotic products such as algae, bacteria and yeasts grown on petroleum or industrial wastes, as well as the recent strange thought of converting wool to human food. The suggested use of wheat germ[8], peanut and cottonseed meals[9a], will not be considered here because, in my opinion, toxic factors and poor stability make them less desirable than soya bean which will be considered in detail. Also omitted is the interesting synthetic meat product called Textured Vegetable Protein[10] made in America from soy protein isolates; its price of about one dollar per pound excludes it from international aid prospects, although it may develop an internal market at the expense of meats with which it easily competes on a price basis.

Product	*Cents/lb Wholesale*	*Dollar/lb Protein*	*PER*
Milk, fluid	(8c/qt)	0.90	3.2
Meat, boneless beef	34	1.75	2.7
Cheese, cheddar	25	1.03	2.7
Skim milk powder	12	0.35	2.8
N.Z. Milk Biscuit	37	1.57	?
Fish Protein Concentrate	18	0.22	2.6
Soy Flour, full fat	8	0.20	2.3
Grass Protein Concentrate	?	?	2.2
Fortified Wheat Flour	1	0.11	?
(1-Amino acid mixture—dry)			3.7
(1-Amino acid mixture—wet)			4.8

The Milk Biscuit developed in New Zealand[11] has many merits, but is very costly when compared with other products. It is easy to handle and distribute in small units, as to school children. It is stable without refrigeration. Its use is aimed at a specific and limited segment of the population, and within that aim it undoubtedly can do a lot of good nutritionally. It was not designed for mass distribution in the most backward areas of a society, nor is it likely to be widely used by pregnant women, who would benefit greatly from it.

I was surprised to learn at the recent ANZAAS meeting in Christchurch that the protein quality of the milk biscuit had never been tested. Apparently it was assumed to retain all of the goodness of the ingredients from which it was made. This is a dangerous assumption, because milk protein in the presence of reducing sugar can deteriorate badly in nutritional quality after certain types of processing and storage, especially if heat has been applied.

Fish Protein Concentrate has long been available in a wide variety of fish meals and fish flours. I wish to discuss the specific product recently developed by the U.S. Bureau of Commercial Fisheries. Freshly caught, minced whole fish, specifically hake and related species, is passed on a conveyor through a stream of isopropanol. This removes fat and water. The solvent is removed under vacuum and mild heat; the product is ground and packaged. The product has 80 percent good

quality protein, high calcium, is stable, odourless, tasteless and white. Unfortunately, the product also contains a high level of fluoride which arises from the incorporated bony tissue. After a very careful review, the Food and Drug Administration finally approved the product for human use, but with certain qualifications. At first, the permitted level of use was limited to 15 grams per day. At this intake the protein would be very beneficial to the consumer in an under-developed country and yet not give enough fluoride to cause mottling of the teeth of the young child. The minimum level for this first sign of fluorosis is about 2 milligrams per child per day.

Later a more realistic tolerance level of 100 parts per million was set for the fluoride content of the product. In practice it may be difficult to produce consistently a product which meets this level. It has been suggested that Whole Fish Concentrate made from shark and other representatives of the Elasmobranchii would have less or negligible fluoride. The absence of calcification of the cartillagenous structure of this group probably also means the absence of fluoride, since this element is part of the apatite crystal structure of true bone.

The estimated cost of the Whole Fish Concentrate (the accepted name of this specific product) is low. However, it is not yet in commercial production, and unforseen situations may push up the cost. The problem of how to incorporate the product into the normal food channels of a country has not yet been met.

Some confusion may arise as to the safety of defatted fish protein concentrates. For example, Huber and Slade[12] reported death of all five calves fed a defatted fish flour. The product they used had been extracted with ethylene dichloride. Work at the Food and Drug Directorate of Canada[13] has clearly shown that toxic materials are generated from the amino acids of fish protein during the extraction with ethylene dichloride. There is a long history of adverse effects, especially in ruminants, caused by the feeding of products defatted with chlorinated solvents. On the other hand, products defatted with isopropanol, ethanol, hexane and similar solvents are completely safe.

Soy Flour, full fat, should have a bright future. Only normal agricultural skills are needed to grow the bean and it does wonders for the soil, since it is a legume. The technique for producing high quality soy flour for human use is not beyond the capacity of most emerging countries. A major technological breakthrough in producing soy flour, full fat, for human consumption has come into being with the development of the continuous extrusion process[9b]. The cleaned and dehulled fresh beans are passed continuously on a screw conveyor which crushes the beans through orifices of specific size. Friction while passing through the orifices causes a flash high heat for only a few minutes. This brings out the full nutritional quality of the bean by destroying the antitrypsins and the haemagglutinins, but without any damage to the protein or the fat. Microorganisms are destroyed in the process. The extruded bean is caught on conveyor belts which pass through a flowing warm air chamber for drying. The product has very good shelf life, and an appearance, colour and taste which are superior to the usual commercial soy meal products for animal feeds. However, it does have a distinct flavour, taste and colour which may limit its acceptance by some people. A highly industrial society would wish to separate the soy oil for manufacturing a variety of products, such as paints, plastics, linoleum base, margarines, detergents, etc. The absence of technology in the developing countries, however, does not provide this major outlet for the soy-oil, and here it is far wiser to retain the oil in the food-use product, as in the full-fat soy flour described.

Grass Protein Concentrate has some interesting and even exciting possibilities. For some reason it seems to be difficult to accept that plant leaf has fine protein equal in nutritional quality to casein or soybean meal. It is a shame to waste such good protein on

ruminants. Mr. Lancaster at Ruakura assures me that in the Waikato the average yield of the rye grass-clover pasture is 12,000 pounds of dry matter per acre per year. With irrigation this increases to 16,000 pounds per year. With proper harvesting the equivalent yield in terms of grass protein is 3,000 pounds per acre per year. For comparison, the intensive fattening land in the North Island produced an average of 30 pounds of meat protein in 1966. This is a ratio of 100 to 1 (grass protein to meat protein). Even if the figures for pasture protein are only half the Waikato experience (as indicated by Professor Latimer of Massey University[14], who based his estimates on experience in the United Kingdom), it is still evident that grass could indeed be an answer to the world protein problem.

There are, however, two high hurdles to clear. First, the technology of production, and second, the technology of dietary use and acceptance.

A successful technique for production was recently published by a group at the University of Wisconsin[15]. The success of the process depended on spray-drying of the grass juice, instead of the difficult, destructive, and costly coagulation and drying techniques worked out over so many years by Dr. Pirie[16] of Rothamsted, and now being looked at by Professor Latimer of Massey University[14].

In the Wisconsin procedure the harvested grass or alfalfa is crushed in a hammer mill and squeezed. The expressed juice is spray-dried in a conventional apparatus. The chlorophyll and fat (which may have separate economic markets) are removed from the dry powder by two washings with ethanol, and the product is ready for human consumption. It is said to be tasteless and light grey in colour. The finished product has 43 percent protein, less than 1 percent of fat and fibre, and 14 percent ash. The squeezed residue which has somewhat more than half of the protein in the original grass and a much elevated fibre, ought to make excellent fodder for zero-grazed ruminants; or perhaps it could be ensilaged for winter feed.

In spite of Dr. Pirie's advocacy of grass protein concentrate for human food over a period of many years, this product has not attracted serious attention. A symposium on "World Protein Resources" published in 1966 limited its discussion on grass protein to one section of the chapter on the impulse rendering technique (the Chayen process)[9c], wherein it was mentioned that a plant had been established in Israel. However, recent information[17] indicates that the Israeli project has now been dropped because the product was too expensive. This is certainly not surprising when the details of the Chayen process are considered. Five to ten volumes of water are added to the cut grass; this water must later be removed. There are several steps to the process, including centrifugation, separation of three zones, drying, defatting, and so forth. It is interesting that an introduction to the published symposium on protein resources was written by Professor Mark Stahmann who has since led the development of the Wisconsin procedure for spray-dried grass protein.

The technology of dietary use and acceptance will probably be the same for any dry protein concentrate in meal or flour form. Many economic and sociological problems need to be considered. It must be assumed that the central governments of the countries concerned are single-minded and determined in giving high priority to the problem of quality protein production and use for their citizens, and wherever possible, make the introduction of special food concentrates into commonly used food products obligatory rather than voluntary.

Fortified wheat flour is based on the concept that it is commercially feasible to add certain aminoacids in pure form to wheat flour, so that the protein of the resulting product will be equal to animal protein in nutritional quality[18]. To do this requires only four aminoacids. These are *l*-lysine at 0.3 percent, *dl*-methionine at 0.1 percent, *l*-threonine at 0.1 percent and *l*-valine at 0.2 percent on the flour basis. Of these, lysine

and methionine are the most crucial and are presently being added to certain foods and feeds in several countries. There is a rapidly increasing production, trade and use of these aminoacids. Because of this the price has fallen and is now, or will soon be, about one dollar per pound. The lysine is prepared by fermenting molasses with a special organism that produces free *l*-lysine at a level of up to 2 percent in the culture medium. The methionine is produced chemically from ethylene. If the other two amino acids threonine and valine, can be brought to a similar low price, then fortification would cost about one cent per pound of flour, or about 11 cents per pound on the protein basis. Wheat flour has 12 percent protein, so when fortified could furnish man with protein in sufficient quantity as well as quality.

Rice is a different problem. Although it needs only lysine to give it a proper balance of essential amino acids, the quantity of protein, 8 percent, is too low to supply enough for man; other sources must be added to a straight, fortified rice diet. Fortification of items such as rice, which are used as the grain or pellet, is technically a very difficult problem. A flour such as from wheat is technically simple to fortify if the milling is done on a large scale at a central operation. Unfortunately, the food-use pattern in countries like India does not conform to the western pattern, even in the use of such a simple grain as wheat. The grinding is customarily done in the home, or at best at the village level. Fortification, therefore, is not possible unless the use-pattern is changed.

As a control figure for protein quality, the table shows the performance of rats on a diet with a proper mixture of the natural *l*-amino acids[19]. Some natural proteins approach this value of 3.7, notably egg protein. An odd finding has been that when the diet was wet with water to 50 percent, the apparent quality of the "protein" was markedly improved to a value of 4.7; (the theoretically maximum PER is 6.0). The reason for this effect, first noted by scientists at a major canned soup company but confirmed by others, is totally without explanation.

Summary

In summary, the world protein problem does exist. Large segments of mankind do not get enough dietary protein of good quality; they suffer from frank deficiency diseases, and have as a result, less than optimum physical and mental effectiveness. I have seen no evidence that the problem is worse today than in the past; only that the attention given to it now makes us aware of the problem and arouses the resolution to do something about it.

The generally improved prospects for food-grain supplies in the under-developed countries ought to lead to an improved living standard and to increase the demand for better quality proteins. Of the many new and exotic protein sources recently proposed, only soy flour has an immediate and practical application to the problem. Other than this, I see no immediate competitive threat to such excellent foods as meat, cheese and dried milk. The milk biscuit probably has only a limited future, at best.

New Zealand has an economy based on one crop—grass. She ought to explore vigorously *all* of the various ways of marketing the nutritional quality of this crop. The preparation of grass protein concentrate ought to be developed on a commercial, pilot plant operation. The procedure can probably be successful if based on the Wisconsin spray-dry process, but has little chance if based on the ineffective Rothamsted technique.

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BRANCH NOTES

Manawatu

New Zealand Dairy Research Institute

Mr. D. W. King has recently returned to Palmerston North after an extensive tour of North America where he has been investigating problems related to casein.

Dr. J. M. Erskine has resigned from the New Zealand Dairy Research Institute to take up a National Research Council Fellowship with the Canada Department of Agriculture, Research Station, Summerland, British Columbia.

Mr. R. Norris has recently joined the staff of the New Zealand Dairy Research Institute and will work under the direction of Dr. R. M. Dolby on problems associated with butter rheology.

Dr. A. T. Dudani, Principal, Dairy Science College, National Dairy Research Institute, Karnal, India, is visiting the New Zealand Dairy Research Institute and the Departments of Food Technology and Biotechnology at Massey University.

Massey University

Mr. G. L. Lyon, who is completing his Ph.D. thesis, joined the staff of the Institute of Nuclear Sciences in mid-May.

A Geochemical Symposium was held at Massey University on 29-30 May with about one hundred people, including many Australians, attending.

The Department of Chemistry and Biochemistry has completed its move into the new Science Block.

A Biochemistry Meeting was held on 17 May so that university teachers of biochemistry could meet Professor F. Gibson of the John Curtin School of Medical Research, A.N.U., Canberra. The meeting also considered the needs and requirements of a biochemical group within New Zealand.

Miss M. N. Wilson will transfer from the Poultry Research Centre to the Department of Chemistry and Biochemistry on July 1.

Wellington

Branch Committee

Dr. J. F. Young, who is going overseas, has resigned from the Committee. Mr. C. L. H. Stonyer will act as Secretary for the remainder of the term. Miss S. Cocks, who is in charge of the Junior Branch, has been co-opted to fill the vacancy.

Chemical Society Meeting

The first Official Meeting of the Chemical Society (London) ever to take place outside the British Isles will be held in Wellington on 13 August 1969, and will deal with "The Chemistry of Solutions and Melts at Elevated Temperatures and Pressures'. The Chemical Society Local Representative is Professor S. N. Slater, V.U.W.

Victoria University

An evening social function was held recently by the Chemistry Department to discuss postgraduate training in the University. The meeting was attended by most academic staff members of the Chemistry Department and the following visitors: Dr. M. Probine, Director, P.E.L.; Dr. I. Walker, Director, Chemistry Division; Dr. A. Johns, Director, Dept. of Agriculture; Dr. K. Sewell, Ivon Watkins-Dow Ltd.; Mr. D. Blair and Mr. J. Mitchell, Tasman Pulp and Paper Co.; Professor J. Smith, Biochemistry Department, V.U.W.; Dr. and Mrs. Hartley, Cambridge Universtiy.

Dr. Ekkehard Sinn, formerly at the University of Sydney and the University of New South Wales, has taken up a position as Senior Lecturer in Physical Chemistry. His research interests include theoretical chemistry, spectroscopy and magnetism at various temperatures and pressures. Mrs. Judy Sinn is working as a biochemist in the Renal Unit at Wellington Hospital.

Soil Bureau

New equipment obtained recently includes a Unicam SP800 recording spectrophotometer.

Mr. J. D. Raeside, A.R.I.C., has recently transferred to Taita from the Christchurch Office of the Soil Bureau.

Chemistry Division

Mr. P. J. Clarke has retired from the Laboratory after 43 years' service. He was probably the only current staff member who had been appointed before D.S.I.R. was created. At a large farewell gathering, which was attended by Dr. Hamilton and others from Head Office, tribute was paid to his sterling work over the years as the chief forensic scientist and Dominion Analyst. Mr. Clarke and his wife will now be spending some months overseas.

Junior Group

The Juniors had a very successful April meeting—a lecture and film on Plastics presented by Mr. Wyatt, Plastics Specialist of the Central Technical Institute, Petone, to sixty Sixth Formers.

Teaching

The Central Institute of Technology organised a course on Radiochemistry for teachers. Ten teachers spent a very profitable fortnight; the first week there were lectures each morning and practical work each afternoon. The second week was spent largely on practical work using instruments not readily available to teachers. A whole day was spent at the Institute of Nuclear Physics. The teachers concerned feel that they have derived tremendous benefits from this course which was organised by Dr. Garside of C.I.T.

Canterbury

The Canterbury Branch Prize for the best student in second-year chemistry was presented at the March meeting to Mr. M. C. Colley.

The Branch Prize awarded to the best student in Stage III Chemistry at the Christchurch Technical Institute has been won by Mr. G. R. J. Heal of the Riccarton Carpet Company.

University

Dr. C. J. Freeman has returned to the Chemistry Department, University of Canterbury, as Lecturer after spending a year at Heriott-Watt University, Edinburgh, with Professor G. Gowenlock. He will be working with Professor L. F. Phillips in the field of gas phase electron reactions. Dr. John E. Douglas of East Washington State College has returned to U.S.A. after spending a sabbatical year with Professor C. J. Wilkins. Dr. J. W. Blunt, a graduate of the department, has been appointed Lecturer in Chemistry.

The Chemistry Department has recently installed an MS. 902 high resolution mass spectrometer. Dr. G. J. Wright is in charge of this instrument.

Mr. R. Q. Packard of N.Z. Pottery and Ceramics Research Association, Lower Hutt, has been appointed by the University of Canterbury to a short-term Visiting Lectureship within the Chemistry Department. Mr. Packard will take up this position during the second term. He will continue with some of his PACRA work and will be associated with Canterbury physical chemists, especially with those with research interests in surface adsorption. This is the first such appointment to a New Zealand University chemistry department.

Teaching

Mr. D. R. Oldroyd has resigned from the staff of Christ's College, Christchurch, to take up an appointment as Lecturer in the History of Science at the University of New South Wales.

A special meeting for chemistry teachers was held in March to discuss "Instruments for School Chemistry". The programme, organised by Mr. A. H. Wooff of Christchurch Boys' High School, consisted of demonstrations and discussions of the use of

1 a 3 cm. wave apparatus for discussing crystal structure (Mr. A. Carpinter);
2 a low cost pH meter (Mr. P. R. Richards);

3 a low cost gas chromatograph (Mr. A. H. Wooff);
4 a stripchart recorder.

These last three were designed and constructed in the Chemistry Department, University of Canterbury, and were costed in the $70-100 range.

Industry

Mr. E. D. Hanall has been appointed Chief Chemist to the Christchurch Milk Company following the sudden death of Mr. J. G. Wright who had held that position for 24 years.

In April Mr. A. Jessop, Works Manager of the N.Z. Steel Co. Ltd., visited the South Island at the joint invitation of the Canterbury and Otago branches. He lectured to both branches on "Steel from Ironsands."

Canterbury Junior Chemical Society

The Society began its year with a lecture from Professor Vaughan on "Camphor". Professor Vaughan described how the structure of camphor had been elucidated, then discussed how it might be done if camphor was discovered today.

The annual field trip was a Saturday morning visit to Lincoln College where members were shown work in the Biochemistry, Soil Science and Plant Science departments. At the first meeting the K.P. Prize for the member with the best mark in Scholarship chemistry was presented by Mr. S. J. Higgins, Works Manager of Kempthorne Prosser's Hornby works, to Mr. W. Rosenberg.

This year's "Chemistry in Action" lecture was given in April to a large audience by Dr. R. R. Brooks of Massey University. His topic was "Biogeochemical Prospecting."

Otago

Prizes presented by the Chairman, Professor J. Robinson, at a recent meeting of the Otago Branch were: Inglis Memorial Prize, Mr. R. Dolby; N.Z.I.C. Prize, Miss H. G. S. Soysa. Following the presentation, Mr. A. F. Jessop, Works Manager of New Zealand Steel Ltd., gave a highly entertaining and informative lecture on "Steel from Ironsands".

A visit of the Branch to view the Dominion Fertilizer Company's fully-automated sulphuric acid plant at Ravensbourne proved popular.

Retirements

Miss P. Jackson, Senior Lecturer at the Home Science School, and Mr. G. B. Seath, for nine years the Principal of the Dunedin Teachers' College, have announced their retirements.

University

Dr. F. N. Fastier, formerly Associate Professor in charge of Pharmacology and Pharmacy at the Otago Medical School, has been given a personal Professorship.

Dr. G. F. Law has returned to the Pharmacology and Pharmacy Department after spending a year with Professor C. P. Read at Rice University, Houston, Texas, where he studied the transport of amino acids through membranes. Dr. Law's study was supported by a U.S. International Post-doctoral Fellowship of the N.I.H.

NOTICES

AGRICULTURAL SYMPOSIUM

The Manawatu Branch Committee have organised an Agricultural Symposium which members of the N.Z.I.C. are invited to attend. The provisional programme is listed.

Monday, 21 July 1969

2.00 p.m. Dr. G. B. Russell,
"Naturally Occurring Pesticides".
2.30 p.m. Mr. T. W. Jordan,
"Insecticide Design".
3.00 p.m. Tea.
3.30 p.m. Dr. E. G. Brooker,
"Manufacture of some Pesticides".

4.00 p.m. Dr. G. W. Butler,
"Trace Elements in Plants and Animals".

4.30 p.m. Dr. W. B. Healy,
"Trace Elements in Soils".

5.00 p.m. Discussion over sherry.

5.30 p.m. Evening meal in Student Centre.

6.30 p.m. Dr. F. B. Cousins,
"Calcium and Magnesium Metabolism in Plants and Animals".

SCIENCE OF MATERIALS CONFERENCE

A Conference on the Science of Materials, organised by the Institute of Physics and the Physical Society, will be held at the University of Auckland from 17 to 21 August 1969. The theme will be the physical properties and structure of solid materials, with an emphasis on mechanical properties.

The Secretary is Mr. L. R. Greenbank, P.E.L., Lower Hutt.

BOOK REVIEWS

Titrations in Non-Aqueous Media, by I. Gyenes. Published by Iliffe Books Ltd., London, 1967, 461 pages. Price 75/- (U.K.).

In this book, which is an enlarged English version of 'Titrálás nemvizes Kozegben' first published in Budapest in 1960, Gyenes gives a very comprehensive account of all aspects of titrations in non-aqueous solvents. The first chapters contain a general treatment of the theoretical basis of the subject and the methods involved. After dealing with such topics as concepts of acids and bases, and the strengths of acids and bases in various solvents the author discusses solvents, titrants and end point detection, particular emphasis being given to practical aspects. Detailed methods describe the purification of solvents, the preparation of titrants, and the detection of the endpoint by potentiometric, visual and photometric methods.

The second half of the book deals with the analysis of organic compounds classified according to functional group. Details are given and various methods are compared for the determination of a very wide range of organic compounds and pharmaceutical substances. Throughout the book excellent diagrams illustrate apparatus. About 900 references (up to 1964) are given to the original literature.

I consider this to be a very valuable reference book for the research laboratory and for quality control laboratories dealing with organic and pharmaceutical material.

A. D. CAMPBELL.

Chemical Kinetics, by G. Pannetier and P. Souchay. Elsevier Publishing Co. Ltd., Amsterdam, London and New York, 1967. 455 pages, price UK£5.

This book has been written by two professors of chemistry at the Sorbonne and was first published in French in 1964. It has been competently translated by H. D. Gesser and H. H. Edmond of the University of Manitoba and they have added a set of 37 interesting problems as an appendix. The authors have designed their book as a basic teaching tool suitable for second or third year university courses in physical chemistry. It is probably not competitive with the leading textbooks in current use in this field, but it can be recommended as a good supplementary text, particularly in its treatment of heterogeneous reactions.

The first part of this book follows the conventional plan adopted by most treatments of the chemical kinetics of homogeneous reactions. Chapters on general characteristics and measurement of reaction rate are followed by discussions of elementary reactions, reaction rate theories, reactions of simple order, more complicated types of reaction sequences, chain reactions, and solution reactions. The last two chapters, which deal with heterogeneous catalysis and reactions involving the solid state, provide a good introduction to topics which are often neglected in textbooks at this level. The authors give a clear account of the types of catalytic surfaces, the nature of chemisorption, the nucleation and growth of reaction centres, the role of mass transfer, and other

typical features of surface reactions. Throughout the book one finds brief descriptions of a surprisingly wide variety of experimental techniques ranging from flash photolysis and dilatometry to differential thermal analysis and polarography. They also include many non-kinetic methods such as electron microscopy, X-ray diffraction and gas chromatography, thus reflecting the authors' teaching interests. These descriptions are accompanied by excellent perspective drawings which vividly illustrate the principles involved.

The authors have adopted a style well suited for an introduction to the subject; their material is logically organized and all steps in the reasoning are clearly explained. However there is rather too much emphasis on definitions, classifications, theoretical models and their mathematical formulation, while the actual chemical phenomena are often given only slight mention. Except for a short bibliography of textbooks, there are no references to the original literature, and there is a lack of interesting experimental facts which would challenge the student to think about the scientific problems of the subject. There is no mention of isotope effects, tracer techniques, structure-reactivity relationships, or relaxation methods for fast reactions pioneered by M. Eigen, who won the 1967 Nobel prize for his work on chemical kinetics. But these are minor weaknesses which can be overlooked in what is definitely an introductory textbook.

G. A. WRIGHT.

UNITED NATIONS

Request from the Government of the State of Kuwait

SPECIAL FUND PROJECT

Water Resources Centre, Kuwait City

Job Description (KUW-108-SB/Rev. 1)

Post title: Analytical Chemist (Water Desalination Scheme).

Duration: One year.

Date required: August 1969.

Duty station: Kuwait City.

Duties: Under the supervision of the Project Manager, and as a member of a team of international experts, the expert will be expected to:

Direct the routine functions of an analytical laboratory (water, solids, microbiological and metallurgical analysis) which is supporting a pilot plant, prototype and commercial-scale tests of desalination equipment and related treatments;

Work closely with the scale and corrosion engineer to implement bench-scale investigations of new scale and corrosion-inhibiting products and processes; Train and develop analytical skills of counterpart staff of analysts and technicians;

Keep the Project fully informed on all current developments in sampling and analytical techniques applicable to the research and field test programme; and

Perform any other relevant duties as may be required by the Project Manager.

Qualifications: University degree in chemistry or the equivalent;

Substantial experience after graduation in analysis of water, its precipitates and suspensions, and scale and corrosion deposits resulting from its processing and use;

Full conversance with modern analytical techniques, such as UV/IR spectrophotometry, X-ray diffraction, gas and thin-layer chromatograpphy, colorimetry, as well as conventional wet and dry analysis;

Some experience in the organisation and function of a modern analytical laboratory, and in the direction and training of its personnel;

Chemical research, development and field test experience in any of the following areas: water desalination, softening, coagulation, chlorination, etc., protective coating, cathodic protection, corrosion inhibitors, biocides, desirable.

Candidates with experience in metallographic assay of corrosion of specimens and in-service materials will receive special consideration.

Applications should be made to the Department of External Affairs as soon as possible (before 20 June).

REMINDER . . .

N.Z.I.C. Conference

□

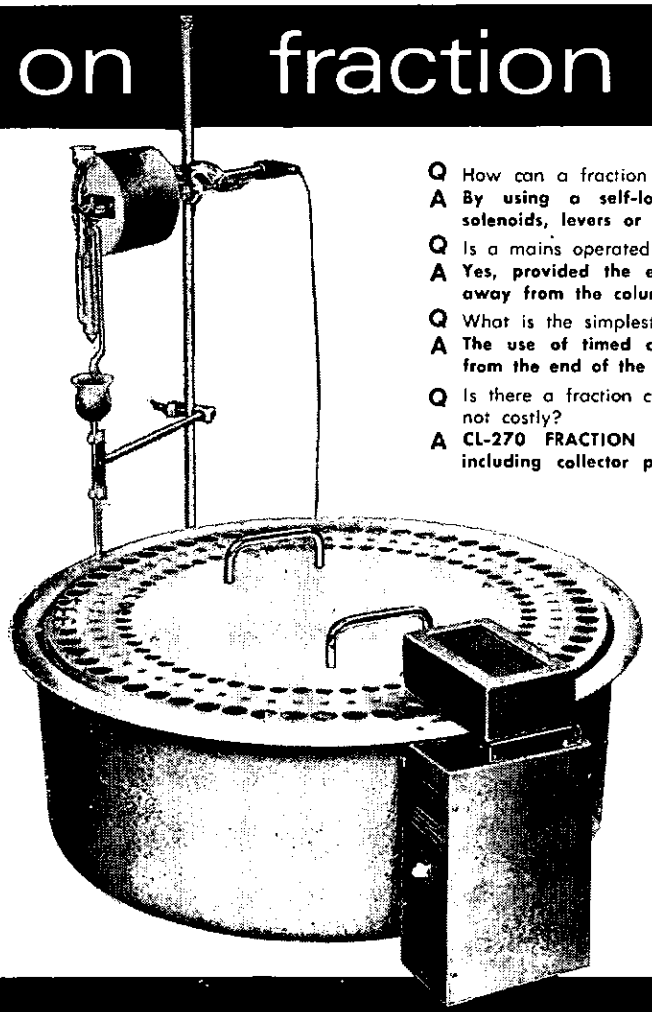
August 25th to 29th

at

Dunedin

QUESTIONS AND ANSWERS

on fraction collecting



Q How can a fraction collector mechanism be virtually tamper proof?
A **By using a self-locating rim-drive with no complicated gears, solenoids, levers or rachets.**

Q Is a mains operated fraction collector safe on a chemistry bench?
A **Yes, provided the electrical circuits are all low voltage and well away from the column outlets.**

Q What is the simplest method of avoiding "tailing"?
A **The use of timed collection so that the eluent is delivered direct from the end of the column into the collecting tube.**

Q Is there a fraction collector which provides all these features and is not costly?
A **CL-270 FRACTION COLLECTOR OUTFIT, for volumetric collection, including collector plate, syphon balance and 5 ml syphon. Only £71 0 0.**

CL-272 FRACTION COLLECTOR OUTFIT, for timed flow collection £95 0 0.

- **Self-standing collector plate holds up to SIXTY 12 mm and 19 mm rimmed tubes.**
- **Bowl construction with drain cock contains no mechanisms; provides large spillage capacity and protects tubes from damage.**
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- **Automatic arrest at end of track with facility for warning or stopping flow of eluent.**
- **Facility for arresting eluent flow during tube advance period.**
- **Swing-up drive arm allows collector plate to be loaded or removed in seconds.**

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Until Mettler constructed the first single-pan substitution balance in 1946, people had to accept (or had been accepting) the inherent errors of the two-pan balance for 6,000 years. Even the first Mettler balance had an accuracy of ± 1/10,000 g.

Then the Mettler research department (120 men) battled against those errors which occur when weighing in the range of hundred thousandths and millionths of a gram.

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We developed an electrochemical treatment for the surfaces of the weights so that dust particles cannot settle on them. To our way of thinking, a few particles of dust weighing one millionth of a gram would be intolerable.

The Mettler researchers have also eliminated subjective weighing errors. The Mettler level-matic compensates automatically slight changes in balance level. The rapid and fine taring simplifies operation. The compact digital indicator makes reading errors almost impossible. For those who are scared of reading errors, the printer, which prints out the result to five decimal places, is available. Or they can combine a Mettler with a recording device or computer.

For a while, our researchers were somewhat disturbed because they had mastered errors in determining weight.

However, they are very satisfied again today because they have discovered many sources of error in the methods of thermal and volumetric measurement.

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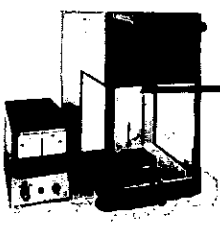
12.6005.72



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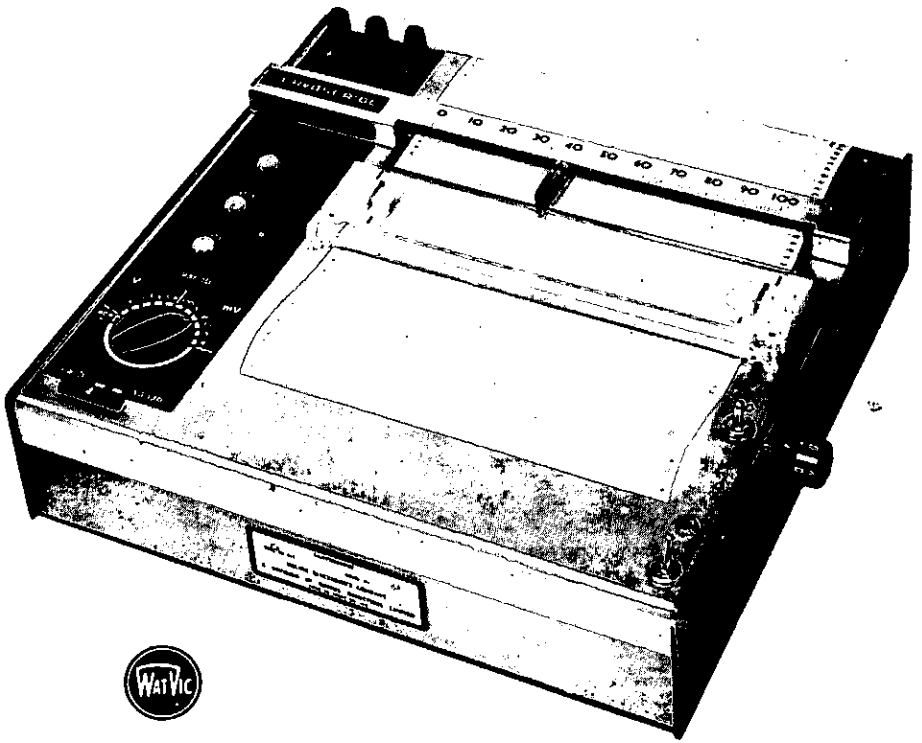
The 'Servoscribe' Type RE511.20 is a single channel desk type potentiometric recorder suitable for small d.c. voltage inputs. The recordings may be made with either an ink or ball pen.

The standard instrument is supplied with a linear scale (0 - 100) but Logarithmic (RE 514.20), Photometric (RE 514.9.20) and Integrating (RE 512.20) versions are also available.

Whilst primarily designed for horizontal operation, a bracket is incorporated to enable the instrument to be operated in the vertical position if desired.

The instrument is capable of accepting inputs from 800μV - 40V f.s.d. which together with a choice of six chart speeds provides full versatility for a wide range of applications in Industry and Research.



Recording Width:	200 mm (8 in).
Chart Drive:	Synchronous with 6 speeds.
Standard Gearbox:	30, 120, 600 mm/h 30, 120, 600 mm/min Other speeds available on request. Note: Chart drive is reversible.

Solid state circuitry is employed throughout

The 'Servoscribe 2' Type RE 520.20 providing two independent input channels for the recording of low level d.c. signals on a common time-coincident basis. also available.

Technical literature available on request.

SERVOSCRIBE, SINGLE CHANNEL RECORDER

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