Physical Medicine in Paediatrics

Edited by

Basil Kiernander

Butterworths

PHYSICAL MEDICINE
IN
PAEDIATRICS

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FOREWORD

A PREVIEW of this book has amply confirmed my pleasure in contributing this Foreword. During the first half of this century, progress in medical science required a breakdown of the broad territories of general medicine and surgery into a series of specialties if knowledge was to be rapidly expanded, although at the time there seemed to be attendant risks of isolation and failure of co-ordination. Now that the specialties are growing into maturity, however, their interdependence upon each other and the increasing overlap of their specialized knowledge and techniques is readily recognized, and is giving rise to a new and healthy medical kaleidoscopy. This is illustrated in several ways in the present volume, in which the Editor has shown—by his choice of contributors—that the modern requirements of physical medicine in childhood go far beyond physiotherapy, as that term is normally understood. An understanding of mother–child relationship is needed; the educational requirements of handicapped children must be appreciated; the wide range of social services available for children must be known and brought into play; such technical advances as, for example, electromyography and the qualities of modern prostheses must be understood; and something much more than a mere nodding acquaintance with normal growth and development is essential if the aptitudes and potentialities of childhood, from infancy through to adolescence, are to be wisely used.

The Editor makes it clear that this book is intended mainly for general practitioners and paediatric physicians and surgeons, and he could well have added all those who are concerned with the physical welfare of children, but it does not set out to be a technical guide for physiotherapists. Nevertheless, the reader will be left in no doubt that the physiotherapist who wishes to be really successful with children, as well as the physician in charge of a department of paediatric physical medicine, requires an attitude of mind and a knowledge of the ways of children which must spring, not from sentimentality, but from a warm and genuine sympathy with the young. One way of expressing this is to say that the physiotherapist whose work with children is to be fruitful must be her own occupational therapist, as indeed is the successful teacher of the young, and to that end she must possess powers of imagination and ingenuity and employ them to the full.

I found the reading of this book most stimulating, perhaps because it set me thinking and asking myself innumerable questions, with not a little heart searching as to whether I was as up-to-date as I would wish to be. I am sure that other readers will share these feelings with me. I commend this book, and wish it 'bon voyage', and at the same time congratulate the Editor and his co-authors on their achievement.

London
May, 1965

WILFRID SHELDON

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CHAPTER 1

INTRODUCTION

BASIL KIERNANDER

THE PURPOSE of this book is to provide a reference book for paediatricians and general practitioners on the uses of physical medicine in paediatrics. As the day of the book by one author is largely outmoded, the Editor has endeavoured to provide contributions from a number of experts dealing with their own special interests in this field and between them to cover the majority of aspects of the subject.

As with any book by various authors there must necessarily be some inbalance because the Editor has felt it right for the contributors to present their articles in the way they wish and he has endeavoured to avoid altering their approach more than necessary. However, he hopes repetition has been avoided as far as possible.

As the book is not written primarily for specialists in physical medicine or for physiotherapists, the Editor has not provided minute details of technique of treatment but concentrates on the main principles involved in diagnostic and therapeutic work carried out in the realms of physical medicine. Similarly, the authors do not attempt to mention every disorder in their field, but only the chief groups thereof.

DEFINITION AND SCOPE OF PHYSICAL MEDICINE

There is no satisfactory definition of this subject but in general principle, amongst other activities, it covers the employment of all physical agents varying from exercises to manipulation, massage, the use of electrical and mechanical apparatus and hydrotherapy in the diagnosis and treatment of disease (Bach, 1950). The term exercise alone embraces the widest concept including the training in activities of daily living and the teaching of trick movements and other methods of overcoming and compensating for physical deformity. Lord Horder (1953) stated that the scope of physical medicine stretched from the fundamental efforts to secure perfect poise and posture, stance, gait and breathing at one extreme, to correction of deformities, help for the paralytic, and the management of convalescence at the other. The physical medicine specialist—or physiatrist as he is known in America—should be a clinician with wide experience of medicine, especially of the locomotor disorders, obtained before embarking on his training in physical medicine. In England he would be expected to have taken an appropriate higher degree, such as the M.R.C.P., before commencing the minimum training of two years in the speciality which is required for the Diploma in Physical Medicine, and comparable experience is essential in other countries.

During his period of training the specialist will receive applied instruction in the basic sciences of anatomy, physiology and physics. From this he will build up his clinical application of physical medicine in diagnosis and treatment; this may be in the realm of positive health, developing and maintaining physical fitness, or in the many fields of disease and deformity where he is

playing both an active role in diagnosis including specialized investigations such as electromyography, and also in the overall management of his patients including those suffering from severe long-term disabilities of the locomotor system. In addition, if the specialist works in a paediatric unit it will be necessary for him to have had a sound background of general paediatrics and detailed knowledge of the development of the normal child. The latter is of great importance. In a physical medicine department of a paediatric hospital the doctor not only has to prescribe appropriate physiotherapy and occupational therapy, but to advise the parents on the approach and management of the child, including schooling problems. It is his duty to assess, often with the help of the almoner, the medico-social background of the whole family, including any other children; too often physically-disabled children have behaviour problems, appear mentally backward, and are frustrated from bad handling by frightened and ignorant parents who need advice and reassurance.

AIMS OF TREATMENT

Prevention of loss of function, disability and deformity

Although this is the least spectacular field of work it is probably the most important. One large group of cases that come under this heading are children noticed to have abnormal postures in very early infancy, possibly due to abnormal positions of the foetus *in utero* for a few months prior to birth, as in torticollis. These infants, if treated by corrective splinting, manipulations and infantile remedial exercises, can often be prevented from developing fixed deformities. Another group of cases helped in this way are children developing early postural defects due to faulty habits. These defects may be static, as in the early stages of flat feet and other errors of stance noticed when the patient is at rest, or dynamic, such as errors of breathing or gait observed on movement. Provided these are not structural in origin they can be helped by postural training in which the child is taught to become conscious and proud of developing a correct posture and physique through remedial exercises. In this way it is often possible to prevent fixed deformities developing in adult life with consequent secondary pathological changes. Even another prophylactic field of physiotherapy is in the use of pre- and post-operative breathing exercises and general graded activity in hospital, which reduces the incidence of post-operative pulmonary complications and encourages the return of function of the locomotor system without postural or breathing defects.

Restoration of function

Where function has been lost as the result of disease or injury, especially in the locomotor system, the physical medicine specialist arranges for the child to be taught a programme of re-educational exercises as an essential part of his rehabilitation. This programme is an individual one drawn up for each patient to cater for his particular disability, whether it be, for example, after poliomyelitis or empyema (to quote two widely different types of case). Sometimes electrical stimulation is necessary to accelerate the recovery of muscle function where exercises alone are inadequate.

Training in compensatory movement where function is permanently lost

In children having experienced permanent disability, such as an amputation, poliomyelitis or a peripheral nerve injury without recovery, it is possible to train the child with suitable exercises and trick movements to compensate for his disability by using unaffected limbs and muscles. In children suffering from cerebral palsy the aim of treatment is to train the unaffected areas of the brain to take over the work of the affected areas by repeated active movements and postures, and the use of the reflex mechanism of the body.

To enable a disabled child to lead as near normal a life as possible

Whether a child is suffering from a temporary or permanent disability, his mental development must obviously be taken into account. This latter can be affected to a certain extent by any abnormal experience, and whilst the child is undergoing specialized physical treatment for a disability, treatment must also be directed to encourage him to lead as near normal a life as possible. Advice to parents on the management of the child and the use of mechanical devices is essential for such cases.

DIFFERENCE BETWEEN A PAEDIATRIC AND ADULT PHYSICAL MEDICINE DEPARTMENT AND METHODS EMPLOYED THERE

Whilst the work of a physical medicine department deals with many fields of paediatrics, as will be seen from the wide range of contributors to this book, the basic apparatus and equipment will, of course, be modified to render them suitable for use with children. Electrotherapy is not employed much in the rehabilitation of children; for example, a recent American survey showed that only 3 per cent of treatment in a paediatric physical medicine department was electrical.

The essential therapeutic measure used in such a department for children is training in active exercises of various kinds, including the activities of daily living.

Some of the differences between a paediatric and adult department are now detailed.

First, the majority of the children seen in such a department have recoverable disorders and only a few are suffering from progressive disease of the locomotor system. Hence the processes of correct rehabilitation and training in the activities of daily living are vital to the child for a happy and successful future. The specialist in physical medicine will have to plan, in conjunction with the physiotherapist, careful individual treatment of each patient.

When treating children, it is essential to provide them with frequent treatments of short duration and this is made possible by the parents always being present when the physiotherapist treats the child, and they are trained in this way to carry out the programme at regular intervals during the day at home.

The parents and, if necessary, the schoolteacher should be interviewed by the doctor and a social worker, and the importance of their co-operation and understanding of the child's problems pointed out to them. Parents, once all this has been explained to them, nearly always co-operate to the full.

Secondly, as mentioned above, exercises are the basic agent employed in a

paediatric department and they cover all the activities of daily living and general physical development, as well as the specialized ones required for the particular disorder from which the child is suffering or has suffered.

Thirdly, where treatment by physical methods is employed for major locomotor disabilities, such as poliomyelitis or cerebral palsy, the programme of supervised treatment will have to continue until adult life, for it will be necessary to teach new special skills as mental and physical development continues and also to counter any fresh mechanical problems arising during this period.

The approach to the patient differs completely from the child to the adult. The basic programme of exercises in a child of average intelligence up to the age of 2 years, the so-called infantile gymnastics, is dependent on reflex action. Such a programme can be devised from early infancy and is most effective to correct suitable cases of torticollis, scoliosis and other such postural defects.

From the age of 2 until approximately 7 years of age, the exercises must be based on play movements, and considerable ingenuity may be required to devise suitable games and ways of obtaining correct movements, while at the same time keeping the child happy and interested in what he is doing. The physiotherapist must be prepared to join in all kinds of games and activities. Capon (1957) has drawn attention to the interest which children have in mimicry and this can often be used therapeutically. He has also commented on the tendency of the small child to indulge in hero-worship and the physiotherapist, or other individual treating the child, can once again take advantage of this. Children become easily bored and short treatments, frequently repeated, are found to be most suitable. Similarly it is wise to change the programme of treatment regularly as a child finds repetitive actions for long periods rather a nuisance and tends to ignore them.

Once a child of average intelligence has reached the age of 7 years, he will begin to understand his need for treatment and the importance of it can be explained to him. The physiotherapist should always discuss freely any problems or difficulties with the child and give him advice and help. He can start at this age to take some responsibility for doing his exercises at home, but it must still be remembered that a child needs to be kept interested. Once again the best results are obtained by clever improvization by the physiotherapist and parents, so that his exercises are carried out as much as possible through normal activities.

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CHAPTER 2

GROWTH

J. M. TANNER

A CLINICIAN presented with a problem concerning growth and development is commonly required to answer one of two questions: (1) The first arises when a child is referred to him for the first time; it is 'Is this child's size, shape, body composition and physical maturity within normal limits for his age, sex, population and cultural subgroup?' (2) The second arises when physical treatment or administration of a drug or hormone has been initiated; it is 'Has this treatment produced a significant effect on the rate of growth of the child in size, shape, body composition or physical maturity?' A variant of this question relates to the ultimate effect of the treatment on the child's size. It is 'What is the adult height of this child going to be and will the treatment being given increase or decrease it?'

Neither of these questions is particularly easy to answer, and the second, with which we shall be particularly concerned, is harder than the first. We shall approach it first by describing the general cause of growth of a child, then the manner in which growth is regulated and the way in which the child's growth responds to starvation or illness.

The human growth curve

Figure 1 shows the growth curve in height of a single boy, measured every six months from birth to 18 years. The height attained at successive ages is plotted in (*a*); the increments in height from one age to the next plotted in (*b*). If we think of growth as a form of motion, then the upper curve is one of distance travelled, the lower curve one of velocity. The velocity or rate of growth naturally reflects the child's state at any particular time better than does the distance achieved, which depends so largely on how much the child has grown in all the preceding years. The blood and tissue concentrations of those biochemical substances whose amounts change with age are thus more likely to run parallel to the velocity than to the distance curve. In some circumstances acceleration rather than velocity may best reflect physiological events; it is probable, for example, that the great increase in secretion from the endocrine glands at adolescence is manifested most clearly in an acceleration of growth.

The record of *Figure 1* is the oldest published study of the growth of a child; it was made during the years 1759–77 by Count Philibert de Montbeillard upon his son, and was published by his friend Buffon in a supplement to the *Histoire Naturelle*. It shows clearly that, in general, the velocity of growth in height decreases from birth onwards, but that this decrease is interrupted shortly before the end of the growth period. At this time, from 13 to 15 in this particular boy, there is a marked acceleration of growth, called the adolescent growth spurt.

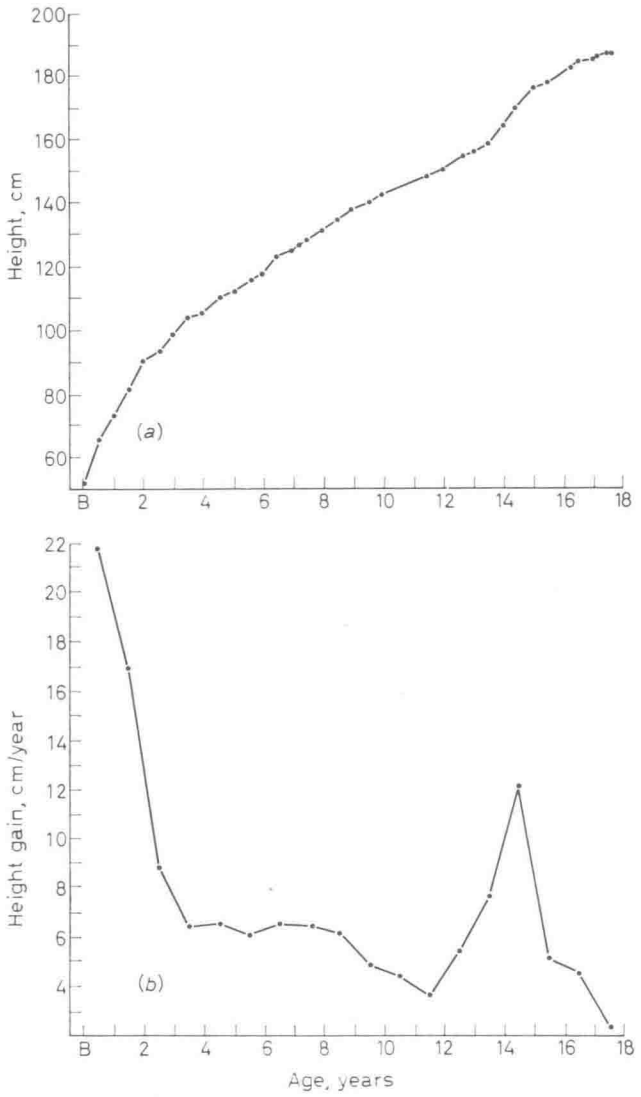

Figure 1. Growth in height of de Montbeillard's son from birth to 18 years, 1759–77: (a) distance curve, height attained at each age; (b) velocity curve, increments in height from year to year. (Data from Scammon)

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A slight increase in velocity is sometimes said to occur between about 6 and 8 years, providing a second wave on the general velocity curve, known as the juvenile or mid-growth spurt. Although *Figure 1* seems to show evidence of it, examination of many other individual records from 3 to 13 fails to reveal it in the great majority; if it occurs at all, it is only in a minority of children.

This curve, in its general form, characterizes many of the tissues and dimensions of the body. Most skeletal and muscular measurements follow its course as do the dimensions of organs such as the liver, spleen and kidneys. But the brain, the skull, the reproductive organs, the lymphoid tissue and the body fat have curves of their own.

In *Figure 2* curves for reproductive organs, brain and lymphoid tissue are shown, using the size attained by each tissue as a percentage of the birth-to-maturity increment. Height and the majority of body measurements follow

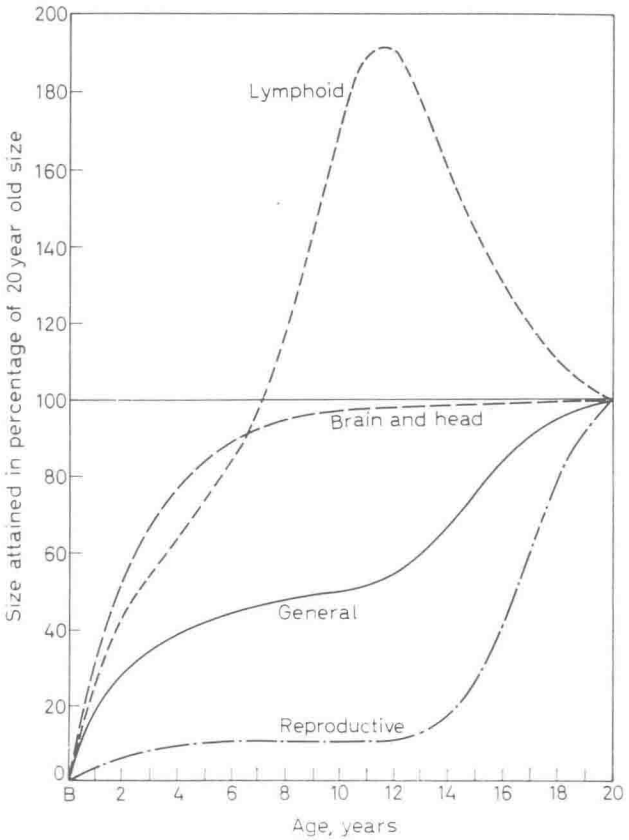

Figure 2. Growth curves of different parts and tissues of the body, showing the four chief types. All the curves are of size attained and plotted as per cent of total gain from birth to maturity (20 years) so that size at the age of 20 is 100 on the vertical scale (redrawn from Scammon, The Measurement of Man, *University of Minnesota Press, 1930). Lymphoid type: thymus, lymph nodes, intestinal lymph masses. Brain and head type: brain and its parts, dura, spinal cord, optic apparatus, head dimensions. General type: body as a whole, external dimensions (except head), respiratory and digestive organs, kidneys, aortic and pulmonary trunks, musculature, blood volume. Reproductive type: testis, ovary, epididymis, prostate, seminal vesicles, Fallopian tubes*

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the 'general' curve. The reproductive organs, internal and external, follow a curve which is perhaps not very different in principle, but strikingly so in effect. Their pre-pubescent growth is slow and their growth at adolescence very rapid; they are less sensitive than the skeleton to one set of hormones and more sensitive to another.

The brain, together with the skull covering it and the eyes and ears, develops earlier than any other part of the body. It thus has a characteristic post-natal curve. Whether it has any adolescent spurt is doubtful, although the issue cannot be decided on present data. A spurt does occur in measurements of head length and breadth, but most or all of this is due to thickening of the skull bones and the scalp together with development of the air sinuses. The face follows a curve midway between that of the top portion of the skull and the remainder of the skeleton. It is nearer its mature dimensions at birth and later than is body length, but has still a considerable adolescent spurt, which is greatest in the mandible. Thus the head as a whole is more advanced than the remainder of the body, and the top part of it, i.e. the eyes and brain, are more advanced than the lower portion, i.e. the face and jaw.

The lymphoid tissue, of tonsils, adenoids, appendix, intestine and spleen, has quite another growth curve. It reaches its maximum value before adolescence, and then, probably under the direct influence of the sex hormones, declines to its adult value.

The amount of subcutaneous fat in the body can be estimated by measuring the thickness of double folds of skin and subcutaneous tissue pulled up from the underlying muscle. Such skinfolds can be most reliably measured on the back of the arm over the triceps and immediately under the angle of the scapula. As in all physical measurements the left side of the body is used. The distribution of skinfold measurements in the population is quite unlike that of skeletal measurements such as stature. Instead of the familiar Normal curve, the distribution is markedly skew with a long tail of high values. Hence the skinfolds have to be plotted on a logarithmic grid, or transformed by taking logs, after the subtraction of 1·8 mm, the thickness of a double fold of skin. Curves for the average values of triceps and subscapular skinfold are given in *Figure 3*.

Subcutaneous fat begins to be laid down in the foetus at about 34 weeks and increases from then until birth, and from birth until about 9 months in the average child (the peak may be reached as early as 6 months in some and as late as a year or 15 months in others). From 9 months the subcutaneous fat decreases, until the age of 6–8, when it begins to increase once again.

It must be noted that we have discussed the *width* of the fat layer; a decrease in this width does not necessarily imply a decrease in the cross-sectional area of fat. In the case of the limbs, the fat is a ring around a musculo-skeletal centre which is itself increasing at all ages; if the cross-sectional fat area stayed constant the width of the ring would be reduced simply by enlargement of the musculo-skeletal core. However, calculations from measurements of fat on x-rays show that the cross-sectional area does in fact decrease during these early childhood years. The decrease is less in girls than boys, so that after 1 year of age girls have more fat than boys. The increase from the age of 7 or so occurs in both sexes and in measurements of both limb and body fat. At

adolescence, however, there is a considerable decrease in limb fat in boys (see 'triceps' in *Figure 3*) which is not regained until the late twenties. In boys' trunk fat ('subscapular' in *Figure 3*) a much smaller loss, if any at all, occurs; there is only a temporary halt to the gradual increase. In girls there is a slight halting of the limb fat increase, but no loss; and the trunk fat shows nothing but a steady rise until the age of discretion is reached.

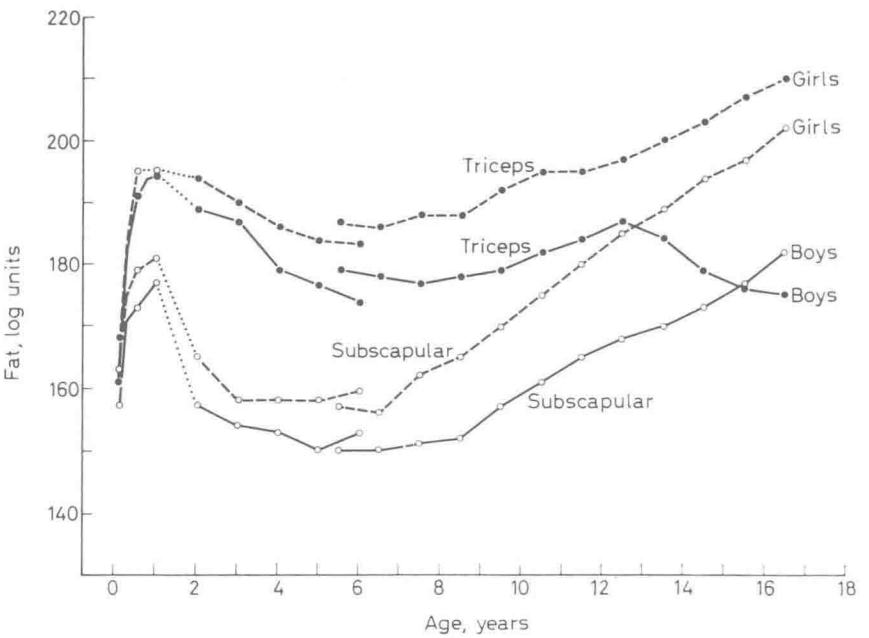

Figure 3. Distance curve of subcutaneous tissue measured by Harpenden skinfold calipers over triceps and under scapula. Logarithmic transformation units. Data 0–1 year, pure longitudinal, 74 boys and 65 girls (Brussels Child Study, Graffar and Asiel, unpublished); 2–7 London Child Study Centre (Tanner, unpublished) with pure longitudinal core 4–6 of 59 boys and 57 girls and actual mean increments subtracted or added to get means at 2, 3 and 7; 5–16 London County Council (Scott, 1961) cross-sectional, 1,000–1,600 of each sex at each year of age from 5 to 14, 500 at 15, 250 at 16

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Because body weight represents a mixture of these various tissues its curve of growth is often less informative than those of its component parts. In general, however, individual velocity curves of weight follow a similar course to the height curve. Although it is to some extent useful in following the health of a child, weight has the severe limitation that an increase may signify growth in bone and muscle, or merely an increase in fat. Similarly, failure to gain weight in the older child may signify little except a better attention to diet and exercise, whereas failure to gain height or muscle would call for immediate investigation.

The peak of the weight velocity curve is reached very shortly after birth; but the peak of length velocity occurs during the fourth month of intrauterine life. Growth in length proceeds slowly during the first two months of