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RECENT ADVANCES IN THE TECHNIQUE OF PROGRESSIVE RESISTANCE EXERCISE

BY

I. J. MacQUEEN, M.B., B.S.

British Medical Association Ordinary Research Scholar

(From the Department of Anatomy, University of Sheffield)

That skeletal muscle responds to contraction against systematically increased load by increase in power and hypertrophy has long been a matter of common observation. Indeed, the legend of Milo lifting a calf every day until it grew into a bull is evidence that the principles of progressive resistance exercise have been known since ancient times. A vast amount of experimental work, chiefly by physiologists on laboratory animals, has sought to demonstrate and explain this phenomenon (Morpurgo, 1897; Siebert, 1928; Steinhaus, 1933; Donaldson, 1935; Donaldson and Meeser, 1935; Hoffmann, 1947).

Clinically, progressive resistance exercise (P.R.E.) is now applied on a scientific basis, evolved partly by trial and error and partly by imitating in some measure the methods used by generations of weight-lifters. DeLorme and Watkins (1951) pay tribute to these athletes by pointing out that they have supplied a "rich heritage of empirical practice" which has been applied to physical medicine. It is now realized that the amount of load used clinically for resistance exercises is often inadequate, for weight-lifters and "body-builders" habitually use poundages far in excess of these in order to develop their massive hypertrophy and power, with no harmful effect in the absence of respiratory or circulatory disease.

It is not generally realized how much the actual technique of exercise has been changed in recent years, particularly by laymen practising P.R.E. for the purpose

of breaking Olympic weight-lifting records or developing the skeletal musculature. It is the object of this paper to describe the regimen for producing muscle hypertrophy and that for producing muscle power, a distinction not usually made in medical literature, and to consider their clinical applications.

Apparatus

For load-resisting exercises, ordinary inexpensive disk-loading barbells and dumb-bells are used (Figs. 1 and 2); they are almost indestructible and are simple to adjust. The dumb-bell rod, 1 in. (2.5 cm.) in diameter and 18 in. (46 cm.) long, can be easily adjusted for use as a swingbell when desired (Fig. 3). Useful additions are a neck harness (Fig.

FIG. 1.—Standard disk-loading barbell. Graduated iron disks loaded with 4 ft. (122 cm.) between inside collars on 6 ft. by 1 in. (183 by 2.5 cm.) bar. FIG. 2.—Standard disk-loading dumb-bell. Graduated iron disks loaded with 9 in. (23 cm.) between inside collars on 18 by 1 in. (46 by 2.5 cm.) bar. FIG. 3.—Swingbell. Graduated iron disks loaded centrally on standard dumb-bell rod, for use in certain two-handed exercises.

FIG. 4.—Neck harness. It can also be used so that weights hang from the back or side of the head, with exerciser lying in supine or lateral positions and the head extending beyond edge of table. FIG. 5.—Iron boot, cored beneath instep to receive a dumb-bell rod for increased resistance when desired.

4) and a pair of iron boots (Fig. 5). Experience has taught that this simple apparatus is better than helical springs, cycling machines, spring grips, torsion bars, and other forms of apparatus.

In order to concentrate the resistance of weights on certain muscle groups, weight-trainers sometimes handle the weight while lying on "incline" or "decline" benches set at varying angles. A bench, the slope of which can be adjusted, is

a useful adjunct for applying refinements of technique, and an ordinary gymnastic bench with hooks at one end for attachment at various levels to wall-bars can be used. A detailed description of the indications for the use of the incline and decline benches and other special equipment of the body-builder is beyond the scope of the present article.

The Hypertrophy or "Bulk" Programme

As the names suggest, this programme of exercises is designed primarily to stimulate muscle hypertrophy. Although such a programme will greatly increase the strength of the exercised muscles, it will not do so to the same degree as the "power" programme, described below.

The essential characteristic of the bulk programme is that all weight-lifting exercises are done in sets of lifts (or "repetitions"), the weight not being put down until the completion of a certain number (or set) of repetitions. In fact, it is colloquially known among weight-trainers as the "set system." A questionnaire sent to the seventeen area finalists of the 1953 "Mr. Britain" physique contest revealed that nearly all exercised on three days a week only (Monday, Wednesday, and Friday), and used the following system of resistance-repetitions:

Finalist	Sets	Repetitions
A	2	8-10
B	3	8
C	3	8
D	5-10	10
E	3-6	10
F	3	15
G	3-4	8-12
H	3	10
I	3	5-8
J	4	8
K	3	10
L	4	8
M	3-4	5-8
N	4-5	8
O	2-6	6-15
	Mean 3.7	9.16

In practically every case the weight used was the maximum that could be handled for the stated number of repetitions—for example, if three sets of ten repetitions were used, then every set was done with the ten repetition maximum (10 R.M.—the heaviest weight which can be lifted ten times). In the past, weight-trainers used to start with a weight less than the 10 R.M. and increased the load with each set of ten repetitions until the actual 10 R.M. was reached. This method has become obsolete, as it does not produce as rapid or as great an increase in muscular bulk as the set system employing the maximum weight that can be handled for every set of repetitions. Almost the only time when less weight is used is as a "warm-up" preparatory to the proper work-out. Furthermore, experience has shown that if less than the ten R.M. weight is used habitually for considerably more than ten repetitions and more than four or five sets are performed on one muscle group, then not only do the muscles fail to grow, but they may actually become smaller. In the experience of body-builders, such a system of "high repetition, low resistance exercise," although usually increasing stamina and muscular definition, never substantially increases muscular bulk.

For the lower limbs, particularly for the calf muscles, which are notoriously difficult to develop, exercises are done with higher repetitions. Typical examples of such schedules given on the questionnaire are:

Finalist	Sets	Repetitions
	<i>Calves</i>	
A	4	20
B	3	20
C	3	25
D	1	20
	Followed by 1	25
	" " 1	30
	<i>Thighs</i>	
A	3	20
B	3	15
C	4	8-12

To the question, "If you do your exercises in sets of, say, eight or ten repetitions, how often do you try to increase the amount of weight used?" the following answers were given:

Once a week	6 finalists
Every fortnight	5 "
Whenever I feel strong enough	3 "
Every few weeks	1 finalist
Between one to four weeks	1 "
As often as possible	1 "

It should be noted that only one man increased his poundage "as often as possible," for this method is characteristic of the power programme and these 17 men were body-builders. They were more interested in developing muscle hypertrophy than increasing power for breaking weight-lifting records.

The question "How often do you alter your lifting programme?" brought the following answers:

Every 4 weeks	1 finalist
" 4-6 "	1 "
" 6-8 "	1 "
" 2 months	3 finalists
" 3 "	2 "
Once a year	1 finalist
Whenever I feel stale and have reached a sticking point on a schedule	8 finalists

Frequent change in exercise routine, by varying the type of movements and sets of repetitions, is essential to prevent boredom and staleness, and, what is more important, to ensure continued progression.

Refinements of Technique in the Hypertrophy Programme

There are many refinements in the actual technique of exercise, but only the most important are mentioned here.

1. "*Flushing*."—Flushing is a method of exercising which is employed in the belief that it keeps the exercised muscles well flushed with blood throughout the exercise period. After carrying out the usual regimen for a particular muscle group, say three sets of eight repetitions on a movement in the vertical plane—for example, the "slow curl" as defined in the Official Handbook of the British Amateur Weight Lifters Association—the exercise is changed, and, using the same group of muscles, the weights are raised and lowered as in the "upright rowing" exercise. Alternatively, they may be grasped with the knuckles forward instead of backward (the "rectangular fix"). This method produces very rapid increase in muscle size. A temporary increase of as much as 1½ in. (3.8 cm.) can be made to the circumference of the upper arm in half an hour with this method of exercise.

2. *Muscle "Cramping."*—Muscle cramping is often practised immediately after flushing. More weight than can be managed over the full range of elbow flexion is added to the apparatus, which is then moved over a part of the full range. Alternatively, complete movements are first performed with a light weight; then, as the muscles tire, the action is shortened so that finally a motion of only a few inches is executed while the muscle is already almost completely contracted. This procedure can be tolerated for only a very few minutes, as the muscles soon start to ache intensely, probably because they are working under relatively ischaemic conditions. Very often a mottled flushing of the overlying skin occurs, similar in appearance to the "flare" of the "triple response." Sometimes even small subcutaneous blebs of oedema fluid may appear. Possibly the flare is produced by the accumulation of metabolites or by the liberation of a histamine-like substance within the muscle, causing local arteriolar dilatation by means of an axon reflex. It is very important that immediately after this form of exercise the muscles should be fully stretched so as to avoid any permanent shortening (muscle-binding) due to their being exercised over a limited range. For example, in the case of the biceps, the elbow should be fully pronated and extended and the upper arm abducted to a right angle and then extended with a series of jerking movements, thus stretching the muscle fully.

3. *Use of a Mirror.*—Body-builders are often derided as "looking-glass athletes" because they sometimes exercise

in front of a mirror. But by exercising in front of a mirror the muscles can be watched as they contract and the athlete is thus able to concentrate very intently on the performance of the exercise, and consequently can very often handle more weight in front of a mirror than away from it. The underlying physiological reason adduced for this practice is to achieve cortical awareness of the muscles exercised, and, in order to get the proper "feel" of muscle in the cramping described above, the exerciser must practise by assuming slightly different positions until he is aware of the muscles being forced into extreme contraction. The incomparable Sandow was famed for his ability to flick at will practically any muscle in the body, and he claimed that this was one of the secrets of his outstanding development. The muscle-flicking alone did not develop his muscles; it was the practice of muscle control while actually lifting weights that was responsible for his success. Every successful body-builder since Sandow has had to master this technique of forcing the muscles into extreme contraction while lifting heavy weights, for it appears to be essential for maximal muscle hypertrophy. This technique comes easily to some, and they are often the "natural" strong men who seem to augment their musculature much more quickly than men who have difficulty in mastering this technique. But for the best results it must be mastered, and practice before a mirror is the surest way. Exponents of muscle control acquire a highly developed kinesthetic awareness. By lifting heavy weights in front of a mirror, the physical culturist improves his motor-learning and is able to lift more weight.

4. "*Peak Contraction*" Principle.—Exercising a muscle so that resistance is maximal at the peak of contraction has long been known by weight-lifters to produce rapid gains in size and strength. For example, in the knee-extension exercise with an iron boot (Fig. 6), resistance is maximal when the knee is completely extended—that is, at the peak of contraction of the quadriceps (and particularly of the vastus medialis). The principle is also applied to the elbow flexors by employing the peak-contraction barbell (Fig. 7). Another variation is to perform elbow-flexion movements with a dumb-bell while seated and leaning forwards ("seated dumb-bell curl"). In this way the forearm does not come

FIG. 6

FIG. 7

FIG. 6.—Knee-extension exercise for quadriceps. FIG. 7.—"Peak contraction" barbell. If elbow-flexion movements are performed grasping a standard barbell (Fig. 1) or dumb-bell (Fig. 2), the resistance diminishes once the forearm passes beyond the horizontal position. But with this apparatus the resistance continues to increase, and is maximal at the peak of contraction of the elbow flexors.

above the horizontal position, even at the end of the movement. By the use of a little ingenuity the principle can be applied to other muscle groups.

5. "*Cheating*."—Contraction of a single muscle to the complete exclusion of all others is most difficult, even for the expert at muscle control who spends many hours practising in front of a mirror. Body-builders have found that increasing the load so that it becomes necessary to "cheat" in order to perform an exercise—for example, by back-bending and the widespread recruitment of neighbouring muscle groups—often does more to develop the particular muscle

at which the exercise is primarily aimed than performing the same exercise in "strict" style, with the virtual exclusion of other muscle groups, and using less poundage. They cannot explain why this is so, but experience has proved that it is. It is part of their "rich heritage of empirical practice." Perhaps the cheating method, which enables a greater weight to be handled, although recruiting the contraction of neighbouring muscles, makes a greater demand upon the particular muscle being developed than does the method of lifting the maximum weight that can be handled in strict style.

From the consideration of these techniques two fundamental principles emerge: (1) the use of as great a resistance as possible over a relatively large number of repetitions, and (2) the concentration of the will on producing extreme contraction of a muscle while it is working against great and increasing resistance.

The Power Programme

This type of weight-training schedule is the one practised by aspirants to national and Olympic titles who strive to lift maximal weights. The weight-lifter is interested in power and not the massive muscular hypertrophy of the body-builder, and his training methods differ accordingly. But just as the body-builder, concentrating on a bulk programme, will concomitantly develop power far in excess of the untrained man, so will the weight-lifter unavoidably develop a certain degree of muscular bulk although following a power programme. Many weight-trainers, of course, use both types of programme, frequently alternating one with the other. In this way they succeed in developing an impressive, powerful, and symmetrical physique and probably become good enough lifters to compete in national contests. Indeed, it is believed, probably correctly, that the body-builder cannot develop a perfect physique by bulk schedules alone, and the top-class weight-lifter needs to incorporate in his training body-building or assistance exercises, performed as in a bulk schedule, in order to develop his maximal lifting potential. It is customary for newcomers to spend at least six months on body-building exercises before starting serious training for competitive weight-lifting.

The power programme is essentially one of decreasing numbers of repetitions performed with increasing resistance. Thus, starting with ten repetitions with the 10 R.M. on a particular exercise, the weight is increased by about 10–20 lb. (4.5–9 kg.) for the next set. Probably only eight, or even fewer, repetitions will be possible with the heavier weight. A further increase of 10–20 lb. (4.5–9 kg.) is made and as many repetitions as possible are performed, perhaps now only five or six. The weight is continually increased in this fashion, and as many repetitions as possible done until it is so heavy that it can be lifted only once. This is the lifter's personal record for that particular lift, or the "1 repetition maximum" (1 R.M.) of DeLorme (1945). As the 1 R.M. is approached the increments in the weight are made smaller so that perhaps towards the end of the work-out an increase of only about 5 or 2½ lb. (2.7 or 1.3 kg.) is made between one set of repetitions and the next.

Having reached the 1 R.M. the lifter may then make two or three attempts at lifting a weight which exceeds his 1 R.M. by about 5 lb. (2.3 kg.). Although not succeeding at first, the idea is to get the feel of the heavier weight, and with constant practice the day comes when he succeeds and establishes a new 1 R.M. By this time strength has usually increased so that he has also broken his 10 R.M. and is now able to start his work-out by doing ten repetitions with a weight perhaps 10 lb. (4.5 kg.) heavier than his original 10 R.M. The frequency with which 1 R.M.s are broken and new ones established depends on many factors, which include the natural lifting ability, intensity and frequency of practice, adequacy of food and sleep, temperament, and the amount of competition—for example, performance put up by fellow lifters in the club—number of "off days," etc.

Not every lifter attempts to exceed or even to reach his 1 R.M. at every work-out; some attempt it only once a week, others once a fortnight or even less often. But many do attempt it "as often as possible," and seem to get good results in terms of increased power and ability to set new records. Weight-lifters seldom start a work-out with as many as ten repetitions; eight is usually the maximum, and a proportion of lifters seldom exceed six repetitions. Generally, weight-lifters tend to exercise more often than body-builders. Five days a week is not uncommon, and more rarely six or even seven. The body-builders believe that alternate days of rest are essential for the anabolism of new muscle tissue, whereas a weight-lifter can go on increasing in strength without concomitant increase in bulk.

Refinements of Technique in the Power Programme

"Washer" or "Miniature Disk" Technique.—Instead of a 5 lb. (2.3 kg.) increase after reaching the 1 R.M., many lifters adopt the washer or miniature disk technique. Large iron washers, weighing about ½ lb. (110 g.) each, are placed one on each end of the barbell. As the new weight now exceeds the 1 R.M. by only about ½ lb. (220 g.) it may be possible to perform a single lift with it, perhaps not in strict style, but cheating a little. After a few work-outs it becomes possible to do the lift in strict style, and a new 1 R.M. is firmly established. The ½ lb. (220 g.) is subsequently added throughout the whole range of the next series of descending repetitions—for example, 10, 8, 6, 4, 3, 2 repetitions—at the completion of which two washers are placed on each end of the bar for the 1 R.M. The process is then repeated.

Decreasing numbers of repetitions with increasing poundage, together with frequent attempts at increasing the weights used, particularly for the 1 R.M., is the key to the development of power. This principle can be applied in an almost infinite variety of ways, and is exemplified in the following training schedules:

	Weight	Sets	Repetitions
Schedule 1	90 lb. (40.8 kg.) (say)	.. 2	.. 4
	100 lb. (45.4 kg.)	.. 2	.. 3
	110 lb. (49.9 kg.)	.. 2	.. 2
	120 lb. (54.4 kg.)	.. 2	.. 2
	130 lb. (58.9 kg.)	Singles until failure	

Work up to six singles, then increase the weight by 2½ lb.–5 lb. (1.3–2.7 kg.) throughout the series.

Schedule 2.—Starting with the 6 R.M. and by decreasing repetitions and increasing poundage, work up to the 1 R.M. Having reached the 1 R.M., the following is carried out: 1-1-1-1-1-1; 1-2-1-1-1-1; 1-1-2-1-1-1; 1-1-1-2-1-1; 1-1-1-1-2-1; then add 5 lb. (2.3 kg.) and revert to six single repetitions.

New Experimental Schedules

New training methods are always being tried and two of the more interesting at present on trial are here described.

The first is a "heavy-and-light" method, in which low repetitions are performed with maximum poundage and cheating allowed, if necessary, for about three sets of five repetitions only. This is followed by decreasing the weight and performing a single set of high repetitions—for example, twenty—in strict style. A modification of this heavy-and-light system is the "multi-poundage" method, in which the lifter does a few repetitions with a heavy weight, and, just as he is failing, say at about the sixth lift, assistants slide a disk off each end of the barbell. The lifter continues without resting and, as soon as he starts to fail with the lighter weight (say after three or four repetitions), two more disks are removed by the assistants, and so on, until about twenty repetitions have been performed. Another way is to start with a light weight, and after every three or four repetitions a disk is added to each end of the barbell until the lifter fails. Although effective, these methods have the disadvantage of requiring two watchful assistants, and are limited to two-handed exercises with a barbell, or the deep-knee-bend with a barbell across the shoulders.

The second new system is one which already seems to promise quite revolutionary gains in strength and bulk. It is the "everyday-hourly work-out." Only one to two sets of the 10 R.M. are performed every hour until ten sets have been completed. This is done every day, except for one rest day a week. Using a system of this type, a 20-year-old American, who started weight-lifting only about a year ago, has already broken by a wide margin several weight-lifting records in the heavyweight class.

Applications

Most weight-trainers participate in other physical activities besides lifting weights, such as running, swimming, gymnastics, etc., for they find that only by mixing other sports with weight-lifting can perfect proportions and fitness be achieved. Moreover, weight-training improves their performances in these other sports. A national weight-lifting coach has been appointed under the Ministry of Education Coaching Scheme, and the Amateur Athletic Association has adopted weight-training officially as a means of preparation for athletics. Weight-training for strength in sport and athletics is far more widely and intensely practised in those countries that led the field in the last two Olympic Games. The number of Olympic athletes who incorporate the principle in their basic training increases yearly (Nicol, 1954; MacQueen, 1954). Its application to the physical improvement of university students and schoolboys is also being extended (Adamson, 1952, 1953; Adamson and Morgan, 1954).

As regards physical medicine, DeLorme and Watkins (1951), in their admirable work on the subject, have stressed the superiority of weights over other apparatus. Strength and muscular development comparable to that of thousands of modern weight-trainers has not been produced in any individual by a "dynamometer" or the other complex machines often used in physical medicine.

It will be noted that, in the set system described above, the weight used in every set was the maximum that could be handled for the stated number of repetitions—for example, three sets of 10 R.M. This differs fundamentally from the method of DeLorme and Watkins (1948), in which a fraction of the 10 R.M. is recommended for the first and second sets ($\frac{1}{2}$ and $\frac{3}{4}$ of the 10 R.M. respectively). As the "maximum" method has been proved to bring quicker and greater gains in strength and hypertrophy, it might be used with advantage in the medical application of P.R.E., in preference to the fractional system, which after long trial has been almost abandoned by weight-trainers. Also, whereas DeLorme and Watkins recommend exercising on five consecutive days a week, only three days, and these alternating with rest days, are used in the hypertrophy programme. In addition to the probable production of better results, this programme would reduce the necessary number of visits by the patient to the clinic.

Frequent change in exercise routine has been proved to be essential to ensure progression in the enthusiastic physical culturist. It is therefore important to vary the programme for patients, particularly as many lack enthusiasm for a heavy exercise routine.

It is suggested that exercising before a mirror might prove to be a valuable aid to motor-learning for patients unaccustomed to the intense contraction of localized muscle groups against heavy resistance. If the methods were combined with attempts at forcing the exercised muscles into extreme contraction, even better results might be obtained.

DeLorme (1945) has observed that when the knee-extension exercise is performed with an iron boot the resistance is maximal at the peak of contraction of the quadriceps, whereas with pulleys the resistance diminishes as the quadriceps is contracted. It might prove profitable to devise movements for applying the peak-contraction principle to many other muscle groups.

The success of the cheating method suggests that the importance at present attached in physical medicine to the

strict performance of an exercise may be unjustified, and it may be undesirable to induce patients to try to use a single muscle without employing neighbouring muscle groups. In any case, for the patient with diseased muscles or impaired innervation, with no previous experience, it is often impossible to use a single muscle. Conversely, the vigorous contraction of neighbouring muscles against heavy resistance may involve a diseased muscle and thus promote contractions of a strength that the patient could not otherwise produce in it. Watkins (1948) has suggested that "cross-education" might serve as a useful therapeutic tool in cases in which volitional control is unilaterally defective, or in which contralateral muscle groups are rendered temporarily inaccessible through immobilization." Contraction of neighbouring muscles might be even more effective than that of contralateral groups.

Conclusion

Which type of schedule, therefore, should be used—the "hypertrophy" or the "power"? Power is more representative of function than hypertrophy and more likely to be appreciated by the patient than bulk alone. But continued observation of patients in whom normal strength had been restored in the quadriceps muscle, but who had not regained normal thigh volume, revealed that their strength often deteriorated more rapidly than did that of the patients who had also regained normal muscle volume, and, moreover, hospital readmission was more frequent among men who had not recovered normal muscle volume (DeLorme and Watkins, 1951).

Only after the distinction between the two basic types of schedule is realized and the details of lay technique are mastered can we hope to juggle successfully with the enormous variety of resistance-repetition combinations.

Summary

Weights are superior to other, more complex, apparatus for developing skeletal muscle.

There is a distinction between the type of exercise programme used by weight-trainers to develop muscular hypertrophy and that used to develop power.

In the hypertrophy programme, muscle groups are usually exercised on alternate days, in three or four sets of eight to ten lifts, the weight used being the maximum that can be handled for the given number of lifts. If more sets and lifts are used habitually, the optimum resistance-repetition combination for producing hypertrophy is exceeded, and the muscles may even become smaller.

In the power programme, the commencing weight is never less than the maximum that can be lifted ten times. The weight is increased between each set of lifts, and the number of repetitions consequently decreases. Eventually the weight is so heavy that it can be lifted only once. Frequent attempts are made to increase the weights used.

Important refinements of technique, including "flushing," "cramping," "cheating," use of a mirror, and application of the "peak contraction" principle are described in detail, and two new experimental schedules are outlined.

Possible clinical applications of these techniques are discussed.

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CATTLE RINGWORM

BY

A. J. ROOK, M.D., M.R.C.P.

Dermatologist, United Cambridge Hospitals

AND

W. FRAIN-BELL, M.D., M.R.C.P.Ed.

Registrar, St. John's Hospital for Diseases of the Skin

Although the transmission of ringworm from infected cattle to man can hardly have escaped the notice of farmers, the earliest observations recorded in medical literature were made at the end of the eighteenth century and in the early years of the nineteenth century. Ernst, a Swiss veterinary surgeon, described in 1820 the case of a young girl who was infected from a cow.

Gruby in 1843, and Malmsten independently in 1846 described the organism of *Tinea tonsurans*. Many dermatologists continued to deny the parasitic origin of ringworm, but it was accepted and confirmed by Bazin in France. In 1868 M'Call Anderson, of Glasgow, quoted Bazin's work at length and further confirmed the mycotic origin of ringworm transmitted from animals to man. Sabouraud (1894) soundly established the foundations of scientific mycology in his classic work on the dermatophyte and named species of *Trichophyton* transmitted from cattle and horses. He described the faviform trichophyta in 1893.

The Fungi of Cattle Ringworm

The nomenclature of the trichophyta remains confused, and there is no unanimity of opinion among mycologists concerning the identity or otherwise of certain species described in different laboratories. Moreover, some mycologists grant specific status to the variants and subspecies of other authorities.

So far as can be determined from the somewhat scanty literature, cattle ringworm in Western Europe and the United States is caused predominantly by two species of *Trichophyton*:—*Tr. mentagrophytes*, a small-spored ectothrix, and *Tr. discoides* (syn. *Tr. album*, *Tr. ochraceum*, *Tr. faviforme*), a large-spored ectothrix. Little information is available concerning the distribution and the relative incidence of the two species. Those veterinary textbooks that make any distinction between the species of *Trichophyton* usually give greater prominence to *Tr. mentagrophytes* and its variants and subspecies. However, Walker (1950) stated that *Tr. discoides* is the commonest cause of ringworm in cattle in Britain, and that although *Tr. mentagrophytes* infections are common in man they are contracted from a wide variety of animals—horses, sheep, dogs, rabbits, and mice, as well as cattle. Davidson *et al.* (1934) grew *Tr. mentagrophytes* from seven cows during a three-year period at the University of Manitoba. La Touche (1952) reported 24 cases of *Tr. discoides* ringworm from the Leeds area.

Similarly, recent reports from various areas in the United States (Fowle and Georg, 1947; Carney, 1949; Hoerlein, 1945; Jillson and Buckley, 1952) show a marked predominance of *Tr. discoides* infections, and in many of the reports this was the only fungus isolated.

Ringworm in Cattle

The incidence of ringworm in cattle is stated by some veterinary authorities to be high, but we know of no reliable figures. The incidence of the disease appears to vary widely in different parts of Britain, but it is far from uncommon in most rural areas and probably fluctuates greatly from year to year. Sylvest (1949) reported a rapid increase of ringworm infection in cattle in Denmark from approximately 1,000 infections for the year 1939 to over 8,000 for 1943. Calves are affected more often than older animals, which are less susceptible, unless they are in poor condition from disease or malnutrition (Hagan, 1951). The disease is uncommon in milch cows. Stall-fed cattle are more commonly affected than animals out at grass, and outbreaks of ringworm consequently occur, mainly in the winter months. Carrere, as long ago as 1838, before the cause of the disease was known, observed that the contagion might be spread by harness which had been in contact with the infected animals. Muende and Webb (1937) found colonies growing on faecal material in a stable.

It is now known that the fungus will survive for long periods in the debris around stables and for still longer periods on the woodwork of the actual building. Dark damp cowsheds are said to favour the spread of the infection, and infected cattle may recover rapidly without treatment when they are turned out to grass. It is not known whether this spontaneous cure is due to exposure to ultra-violet light or to improved nutrition. In the infected calf the lesions are most frequent on the face, commonly round the eye, on the neck, and around the tail. Broken and twisted hairs penetrate thick white or yellowish crusts composed of dried exudate and scales. The lesions are usually discoid and discrete. Experimental inoculation has shown that they first become evident about the eighteenth day after inoculation and are well established by the twenty-fourth day (Hoerlein, 1945). The eruption generally lasts from six to twelve weeks, the scabs falling off to leave scaly bald patches upon which the hair slowly grows again. If this normal course is disturbed, as is not infrequent, by rubbing and scratching, fresh outbreaks occur within the healed patches, and the condition may be prolonged for six to twelve months or even longer.

Incidence of Cattle Ringworm in Man

Here again no reliable figures are available. Our 39 cases were referred to various dermatological out-patient clinics in Glamorgan and western Monmouthshire over a three-year period (1950–3), during which time approximately 12,000 new patients were examined. A great many cases are undoubtedly treated by general practitioners, and others receive no medical attention. Ashton (1932) summarized the result of an inquiry made among 384 general practitioners in rural areas throughout England and Wales; 296 had seen cases of cattle ringworm (132 only rarely), but the annual incidence and the geographical distribution of these cases were not recorded.

Transmission to Man

The majority of patients give a history of direct contact with infected animals. Table I shows the source of contact with infection in this series. Of the three patients included

TABLE I

Adults		Children		
Farm Workers	Other Occupations	Living on a Farm	Father a Farm Worker	Recently Visited a Farm
23	3	5	1	6