THE POISONOUS PRINCIPLE OF *LATHYRUS* AND SOME OTHER LEGUMINOUS SEEDS.

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(With Plate VII.)

Since remote times man has cultivated many kinds and varieties of peas and beans as food for himself and his domestic animals, and with two notable exceptions there has apparently been little suspicion on his part that they might be potentially poisonous or deleterious. The exceptions are the bitter vetch (*Ervum ervilia* L.) and the vetchling *Lathyrus* (*L. sativus*, *L. cicera* and *L. clymenum*), the former of which ever since Hippocrates recorded the first known epidemic and the latter since the seventeenth century have been recognised as liable to injure farm animals and to cause in man an incurable paralysis of the legs if eaten in too large quantity as part of the daily dietary. The bitter vetch is now only of limited agricultural importance as a cattle food, but lathyrus is extensively grown in France and southern Europe chiefly as fodder for farm stock and also to some extent for human consumption. The peasants cook and eat it like other pulses and the meal mixed with wheat or barley flour is made into bread, hence in times of scarcity and dear cereals an excessive use of it has often given rise to local outbreaks of poisoning. In India and in Kabylia the peas, whole or ground and cooked in various ways, form the staple diet of large sections of the poorer classes, as they are cheap, palatable, and very nutritious, and in times of famine the increased consumption has been the cause of many recorded pandemics. Apart from famines, however, large agricultural populations in some parts of India subsist to a great extent on lathyrus peas (khesari, teora, matra) and in certain States of North-West and Central India 6 per cent. of the total inhabitants are said to be affected in consequence by paralysis of the lower limbs, and in some of the worst villages 10 per cent. or more of the adult males. The condition has always been well known under various names to physicians practising in the countries affected, but in 1873 Cantani (Naples) gave it the name *Lathyrism* under which it is now usually described in text-books of medicine. As very large numbers of mankind habitually consume lathyrus peas it may safely be assumed that they are innocuous when taken as a moderate part of a mixed dietary, and Buchanan states that in some Indian jails 4–6 ounces per person have been given daily for years without any bad results having been observed, while on the other hand, Grandjean and others find that when they form almost the whole dietary paralysis supervenes in 4–8 weeks. But the grain

https://doi.org/10.1017/S0022172400017721 Published online by Cambridge University Press

varies considerably in its content of toxic substance and the results depend partly on this, partly on the amount eaten, and probably to some extent on individual susceptibility. Men are much more liable to be affected than women, in the ratio of 10 or 12 to 1, and boys than girls. Slight cases of lathyrism show merely a certain degree of motor paralysis and spasticity in the lower limbs which may pass off. In more severe cases the paralysis comes on suddenly and may involve the bladder, rectum, and genital organs, while there may also be pains round the waist, lightning pains, loss of sensation, numbness, cramps, and prickling. All these symptoms, if present, usually clear up with the exception of the spastic paralysis which varies greatly in degree and is permanent. Chevallier (France 1841) mentions somnolence as a symptom, Brunelli, who reported eleven cases which occurred in the neighbourhood of Rome (1880), states that after each meal certain of them showed a kind of transient intoxication, and Desparanches, who described an extensive outbreak round about Blois (1829), says that convulsive movements of the limbs is the earliest symptom in some cases. It is evident therefore that the poison may affect any part of the brain and spinal cord, but that its chief and permanent effect is exercised on the motor tracts from the cortex downwards. The general health remains good, and it does not directly shorten life. Lt.-Col. McCombie Young has published a very clear analysis and explanation of the motor clinical symptoms which makes any further account of them here unnecessary[1], and Proust's report on an outbreak in Kabylia also gives very full details[2]. No post-mortem examination of the nervous system in man has ever been made.

As regards the action on animals, the whole plant and the peas are largely used as fodder and the addition of 20 per cent. of the peas to other feeding stuffs is well known to be innocuous except to horses which are peculiarly susceptible. But even when fed entirely on the peas for long periods herbivora and pigs thrive and remain well although they are apt to develop a weakness in the hind legs. Pigs turned into fields of lathyrus to feed have not infrequently died of acute poisoning and sheep and cattle have also died acutely. Ducks, geese and peacocks are readily poisoned by the peas, but pigeons, hens and partridges do well on them although perhaps not quite immune. In a long series of feeding experiments with monkeys, I was able to produce most of the symptoms of lathyrism as seen in man, and by continuing the feeding to bring on more aggravated symptoms, sometimes with a fatal termination. The animals became very paretic and weak muscularly and suffered at irregular intervals from generalised spasmodic attacks in which they were almost completely helpless. Some of them died in one of these attacks, others recovered apparently completely, and others remained permanently paretic. For details and a more extended account of lathyrism I must refer to two previous communications[3].

[1] *Indian J. Med. Research*, 1927, **15**. [2] *Bull. Acad. Méd.* 1883, **12**, 829.
[3] *Edinb. Med. J.* Nov. 1917 and *J. Pharmacol. and Exper. Therap.* 1929, **37**.

The poisonous principle of *L. sativus* and *L. cicera*.

Both the small and large varieties of *L. sativus* peas grown in India and *L. cicera* peas grown in France were used, and no differences were noticed either in their action or chemistry.

The poisonous principle is an acid which may be extracted by macerating the ground peas in cold water or weak alcohol for several days, expressing, boiling the resulting liquid to precipitate albumen, filtering off the albumen and concentrating the liquid in a shallow pan at a very gentle temperature with the aid of a fan. It is very acid in reaction and may be further purified by precipitation with mercuric chloride, treating the filtrate from this with H_2S, filtering off the mercury sulphide, passing a current of air through the filtrate to drive off the H_2S and concentrating at a low temperature to the consistence of a thin syrup. If this is poured gradually and with constant stirring into a large quantity of absolute alcohol an abundant white flocculent precipitate is obtained which is a highly purified extract containing the poisonous substance, sugars, and inorganic salts. It is white and very hygroscopic, but when dried *in vacuo* over sulphuric acid is easily powdered. The yield is about 4 per cent., it is physiologically active, and was used for many of my experiments. The alcohol holds in solution more or less of the active constituent, sugars, etc., and these may be recovered by distilling off the alcohol to a small bulk and again precipitating with absolute alcohol.

From the extract the active acid may be obtained by dissolving in a small quantity of water and carefully precipitating with a saturated solution of lead acetate. The lead salt is not insoluble in acid water, and unless care is exercised in this respect much may be lost. The lead precipitate is decomposed by H_2S, filtered, the filtrate freed from H_2S, concentrated to a syrup and poured into absolute alcohol which precipitates the acid as a salt in combination with various bases present in the peas. It can be converted into a sodium salt, by dissolving in water and carefully neutralising with sodium bicarbonate which throws out the insoluble calcium and magnesium carbonates and they are filtered off. The filtrate on drying yields a white powder consisting chiefly of the sodium salt of the active acid which is very soluble in water. The acid may be obtained from it by adding slight excess hydrochloric acid and extracting with hot 85 per cent. alcohol. On allowing the alcohol to evaporate slowly it usually dries up to an amorphous glassy mass, but occasionally small quantities of acicular crystals formed. These have not been obtained as yet in sufficient quantity for a thorough chemical examination, but research in this direction is being continued.

In a former research I obtained a small quantity of the same substance, but described it as an alkaloid, the mistake arising from the presence of a trace of organic matter which gave precipitates with many of the usual alkaloidal reagents.

Experiments with the active principle and the extract.

Monkeys.

A monnet Monkey got hypodermically 0·8 grm. of the sodium salt of the active acid. In 10 minutes it had become very weak and lay down flat or on its side; it could not stand, could only drag itself about, and at times its legs were stiffly stretched out as if in spasm. This lasted all day, on the following day it was merely paretic, and on the third day apparently normal.

When 2–4 grm. of the purified extract was given hypodermically the effects

varied from weakness to almost complete helplessness and spasmodic attacks. In the former case the animal sat with its back bent and its head down between its legs and looked drowsy and indifferent. If roused it moved about but had lost all its agility. When more severely affected it lay down and all its joints were flexed as if the weakened extensor muscles had been overcome by the also weakened flexors (Plate VII, fig. 1). Sometimes it developed irregular clonic and tonic spasms of groups of muscles in which the joints might be more firmly flexed. One limb might be much more affected than the others and might remain much longer affected. The effects might pass off in a few hours or might last in a modified degree for 3 or 4 days.

A peculiar feature of the action on monkeys is that marked paresis or a spasmodic attack sometimes come on suddenly when the animal is getting no lathyrus, and often a very considerable time after the last administration and when it is apparently normal. Thus a monkey which had been given nine hypodermic injections at intervals from January to July suddenly developed a severe convulsive attack on September 3rd. In January and July of the following year it got two further doses. It remained perfectly well except for a slight degree of permanent paresis of its limbs until September 20th, when it was found paralysed and moribund. Its organs were healthy and there was no gross apparent cause of death, but minute examination of the nervous system revealed extensive degenerative changes. The same delay has been observed in horses. In an outbreak in a stable of 80 horses at Liverpool the last case occurred 8 weeks after the lathyrus feeding had been stopped. It is improbable that the poison remains so long in the nervous system and there is the further fact that the animals appear to be quite or nearly quite well previously, hence the most likely explanation is that the lathyrus initiates irritative and degenerative changes in the nerve fibres and nerve cells which increase progressively and at times give rise to the paralytic convulsive attacks.

The electrical reactions of the muscles and motor nerves remained normal, and this makes it improbable that the peripheral nerves are directly affected.

Rabbits.

Rabbits with 2 grm. of the extract given hypodermically may show no effects or only some weakness in the legs which does not last long. This is not surprising, as rabbits thrive well when fed exclusively on the peas for months. One rabbit (500 grm.) became very paretic and died from gradual paralysis.

Frogs.

In frogs the sodium salt and the extract are marked muscle and nerve poisons. I obtained a small quantity of the active acid in crystals and when 0·02 grm. of this was neutralised with sodium bicarbonate and given hypodermically the frog became paralysed in 3 minutes due to an action on the brain and spinal cord. The heart went on beating for 2 hours. After 0·01 grm.

there was more or less paralysis for a few hours, and this was succeeded by tetanic spasms or greatly increased spinal reflexes. The muscles in the neighbourhood of the injection were poisoned and often irresponsive to the faradic current.

When 0·1–0·2 grm. of the extract was given the frog became more or less paralysed for some hours, and this was succeeded by increased reflexes which might last for days if the animal survived.

Lesions in the brain and spinal cord of monkeys.

The cord showed degeneration of nerve fibres in all its columns and in all of about an equal degree, along with degenerative changes in the anterior and posterior nerve roots. The degeneration is very scattered and widespread, but does not involve large areas, only fibres here and there being picked out. In the brain the fibres of the corona radiata, crura cerebri, pons and medulla oblongata presented similar changes, both motor and sensory tracts being involved. In the cerebellum the degeneration was much less in degree. Some of the large nerve cells in the cortex cerebri, corpora striata, optic thalamus and cord showed all degrees of chromatolysis and in some of them the cell nucleus had disappeared. These pathological changes correspond with the symptoms observed in monkeys. The viscera were normal and healthy.

Prevention.

In the seventeenth century two Dukes of Württemberg in succession prohibited the cultivation of lathyrus in their domains, and in India and Algeria similar attempts have been made locally, but these measures have always proved unpopular and quite ineffective. Lathyrus peas are probably not more poisonous than many other kinds of peas, but poverty and primitive inefficient agriculture compel large populations in India to eat them in excess, and hence a more varied and better balanced dietary is the true preventive if it could be attained. Failing that, soaking the decorticated peas or the meal overnight in twice their weight of soft cold water and draining off the water with gentle pressure deprives them of at least one-quarter of the toxic substance. The cold water removes very little protein and no starch. Undecorticated peas part with a mere fraction of the active principle to cold water.

In a vegetarian population in times of famine and generally a lathyrus diet should not be supplemented, as it often is, by other pulses, which may be just as dangerous, but by cereals, fresh vegetables and fats, all of them, however, much more costly.

Other leguminous seeds.

I have extended these observations to a number of other well-known pulses, but owing to the time and labour involved have so far only been able to overtake a few of those most widely used for human food or cattle fodder. Others, however, are being investigated.

The result is somewhat surprising, as it demonstrates that they can be as toxic as lathyrus, but like it different samples vary a good deal in toxicity. The active principle seems to be the same in all and practically the same methods of isolating it or obtaining a highly purified extract were employed.

ERVUM LENS—LENTILS.

Lentils are used as a staple food by many millions of human beings and are supposed to be one of the earliest plants reclaimed from its wild state and cultivated by man.

Monkeys.

A Bonnet monkey ($3\frac{1}{2}$ kgm.) was fed on a diet of lentils cooked by steaming and heavily flavoured with orange juice. It ate about 120 grm. per day and some milk and fruit were given in addition.

In 3 days the left arm was paretic and held somewhat adducted and bent at the elbow. During the next 6 weeks it gradually lost its wonted agility, its muscles became weak and tremulous, it climbed slowly and circumspectly and sometimes fell. Latterly it often sat for long periods with its head down between its legs and its back bent, and having slight general muscular tremors, the whole picture being very reminiscent of an advanced case of paralysis agitans (Fig. 3). It ate well and put on weight but varied a good deal in alertness. On the 49th day it became much worse and moved about only on all fours; the flexor and extensor muscles did not act in unison and this gave it a very jerky, slow gait. There were coarse muscular tremors. It died on the 52nd day from gradually deepening general paralysis. Its organs were all healthy, but on microscopic examination the brain and spinal cord showed similar degenerative changes to those of lathyrus poisoning. Judged by this feeding experiment this sample of lentils proved more poisonous than most samples of lathyrus peas which I have used on monkeys.

A Bonnet monkey was given hypodermically 4 grm. of a purified extract. It sat crouched up all day and very inactive. Two days later 5 grm. were given and in 10 minutes it could not support itself upright and was extremely feeble. A day later 2 grm. were given and in a few minutes it was very paretic. In half an hour it had clonic spasms of the right arm and head and 10 minutes later this passed into general clonic convulsions with all its joints flexed, exactly as has been described with lathyrus (Fig. 2). These gradually passed off and 6 hours later it was moving about but with its joints still slightly flexed. Next day its arms were extremely weak and the digits flexed, but, on the day following, it had regained most of its normal activity.

Rabbits.

A rabbit which received 4 grm. of the same extract hypodermically showed no symptoms whatever.

Frogs.

A very large dose of the crystalline active acid (0·07 grm. neutralised with sodium bicarbonate) caused complete paralysis in a large frog almost at once. It was examined an hour later. The heart had stopped and most of the muscles did not react to electric stimulation. Smaller doses caused depression followed by increased reflexes.

The purified extract had a similar action according as the dose was large or small.

Pisum sativum—THE COMMON CULTIVATED PEA.

Peas are imported into this country from many parts of the world and when fully ripe may have either a yellow or green colour. Both kinds were examined. No observations were made with fresh green peas. The yellow peas used were imported from Chile and Calcutta for ordinary sale here.

Monkeys.

A monkey (3·2 kgm.) was fed on "split" peas cooked by steaming, along with some fruit and milk daily. It ate about 100 grm. per day. After a month no toxic symptoms were visible. It was then given in addition water in which 200 grm. of the peas had been soaked for 24 hours. The effect of the increase of dose was very marked. After each meal it became inactive and drowsy and sat very much bent down for 2 or 3 hours. It was supplied with such water for 5 days in succession when it had become very paretic and dragged its right leg. It remained in this condition more or less till the 54th day when it suddenly became much weaker (Fig. 6) and on the 55th day was almost completely helpless (Fig. 4), but drank milk freely. On the 56th day it died from gradually deepening paralysis.

A somewhat larger monkey received 4 grm. of a highly purified extract hypodermically. In a few minutes it became less active and remained so all day, getting gradually worse. On the 2nd day it was more paretic still, hardly moving unless roused, and sat with bent back and its chest resting on its legs. If roused it moved stiffly and with bent knees. It continued much in this condition for 5 days longer and died on the 7th day from gradually increasing paralysis.

The pathological changes in the brain and spinal cord were similar to those already described as occurring with lathyrus. The viscera were all healthy.

Frogs.

When 0·05 grm. of the pure crystalline acid (neutralised with sodium bicarbonate) was injected under the skin of the back the frog became completely paralysed and insensitive to stimuli in 10 minutes. Five hours later the heart

was still beating feebly, but the back muscles were irresponsive to the faradic current.

With 2 ctgrm. the initial paralysis was followed in 3 hours by tonic spasm of the limbs. It remained paretic with increased reflexes but had recovered fully on the 3rd day.

The purified extract given in considerably larger doses had a similar action.

Dry green peas are a variety known as the "blue" pea, owing to its bluish green colour. They are grown to some extent in England but are mostly imported from the Continent. No experiments were made with them on monkeys, but their chemistry and their action of frogs and rabbits differed in no way from the yellow pea.

SOYA HISPIDA (GLYCINE HISPIDA)—THE SOYA BEAN.

This is a medium-sized bean with a white shiny seed-coat. In the Far East it is next to rice the most important vegetable food, being eaten by all classes and in some form or other almost at every meal. It is very rich in protein (34 per cent.) and in fat (20 per cent.), is therefore very highly nutritious and forms an excellent complement to rice in a national dietary. It is eaten to some extent boiled like other beans, but in China and Japan is manufactured by elaborate processes into a great variety of products (so-called "cheese" of different kinds) which are important foods. Soy sauce is also made from it. It is imported into this country in large quantities, the fat (a thickish yellow oil) is removed by solvents and the meal is then used as a cattle food.

For the most part it has proved highly satisfactory as a cattle food, but from time to time cases of poisoning have occurred from its use, sometimes on a considerable scale, and have been reported in the veterinary journals. For my experiments the defatted meal was used.

Monkeys.

A monkey was fed on 120 grm. per day with some fruit in addition. For a fortnight there was no change and then it was given drinking water in which 100 grm. of the meal had been soaked. This addition was followed at once by marked paresis, the monkey became much less active and often sat bent up. When 200 grm. of the soya meal was macerated in its drinking water it became very weak and only moved about slowly and carefully with no spring in its legs and its back and joints bent. It was drowsy and somnolent (Fig. 5), but by next day had always partially recovered. The 120 grm. *per os* sufficed merely to keep it very inactive and feeble, but any considerable addition in its drinking water at once intensified its symptoms. The experiment was stopped on the 31st day; it was fed on bread and milk and fruit, the paresis gradually passed off, and in a fortnight it seemed perfectly normal again.

A Rhesus monkey was given 0·7 grm. of the sodium salt of the active acid hypodermically. In a few minutes it lay down and all day was hardly able

to sit up. Next day it moved about but was not able to climb; on the 3rd day it was running about, climbed very slowly, and its muscles were weak. On the 4th day it was about normal except that its toes were much flexed.

In this monkey the motor tracts seemed to be the only part of the nervous system affected. There was no drowsiness or somnolence and it remained quite alert.

A month later the same monkey was given 5 grm. of a purified extract and remained very paretic for 4 days.

Rabbits.

Rabbits showed no symptoms with 4 grm. of the purified extract. When 1 grm. of the sodium salt was given the animal became very feeble and had marked weakness in its hind legs.

Frogs.

I obtained a small amount of the active acid in well-formed acicular crystals. When 0·03 grm. neutralised with sodium bicarbonate was administered to a large frog hypodermically it became paretic at once and 35 minutes later its right leg was in tetanic spasm while the rest of its body was very limp. In an hour it had severe general tetanus and an hour later was killed. The heart was still beating, the back muscles did not respond to electric stimulation, but the other muscles, the spinal cord and the motor nerves responded. Larger doses rapidly caused complete paralysis and stopped the heart. The muscles were usually more or less excitable to the faradic current as they had not had time to be completely paralysed. With 0·01 grm. there was marked paresis and 45 minutes later violent tetanus. Next day the reflexes were increased, but by evening had subsided to normal. The purified extract in 0·1–0·2 grm. doses had a similar effect.

Vicia sativa—TARES.

The whole plant is very largely grown for cattle food. The peas as found in commerce vary a good deal in size and have a black seed-coat. For these experiments Russian and Swedish tares were used.

Monkeys.

A Bonnet monkey was given 0·95 grm. of the sodium salt of the active acid hypodermically. In 2 minutes it lay down on its side and for some hours was hardly able to stand or walk. The right leg was often extended in spasm, the other limbs remaining very limp and feeble. Seven hours later it was able to walk stiffly and feebly on all fours. Next day it was very paretic and on the 3rd day had regained much of its normal condition.

The same monkey was given hypodermically 4 grm. of the purified extract. This caused marked general weakness, but especially of the right arm, inversion of the feet and slight flexion of the joints, but it was able to move about. The effect lasted 24 hours.

Frogs.

A dose of 0·01 grm. of the crystalline acid given as a sodium salt caused some depression followed by an increase of reflexes. Larger doses (2–5 ctgrm.) proved to be rapidly acting nerve and muscle poisons.

A dose of 0·2 grm. of the extract hypodermically caused complete paralysis in a few minutes. There was no eye reflex and no response to stimulation. On examination some hours later the heart had ceased to beat and the muscles along the back where the injection had been made did not respond to the faradic current.

Smaller doses caused depression for some hours according to the amount given, and this was followed by increase in the spinal reflexes lasting for several days.

Rabbits.

A rabbit (650 grm.) was not visibly affected by 4 grm. of the purified extract.

Another rabbit (1300 grm.) received hypodermically 1·2 grm. of the sodium salt. It became paretic and lay down on its belly, owing to weakness of the legs. Two hours later it had practically recovered.

ERVUM ERVILIA—THE BITTER VETCH.

The peas are small, triangular in shape, and the seed-coat has a light brown colour. They seem to have been used by the ancient Greeks as food, and Proust states that the Kabyles so use them. The whole plant is grown in Algeria as fodder and there are occasional accounts of poisoning of animals by it and by the seeds.

Monkeys.

A monkey (2 kg.) was given hypodermically 3 grm. of a highly purified extract made from the peas. The only effect visible was some degree of paresis. Next day it received 4 grm. and in half an hour was unable to stand or climb or grip a bar. It continued weak and much less active for some days afterwards, but gradually recovered completely its normal activity.

Rabbits.

In rabbits 4 grm. of the extract had no apparent action.

Frogs.

A dose of 0·2 grm. of the extract brought on complete paralysis in half an hour. Five hours later it was sitting up, very paretic and sluggish but with increased spinal reflexes. Next day its reflexes were much increased, almost to tetanus, and this increase continued during the next 4 days when it died.

With 0·1 grm. the depression stage was not nearly so marked and was succeeded by more or less exaggerated reflexes for some days.

I succeeded in obtaining a small amount of the active acid in pure acicular crystals. A dose of 0·05 grm. neutralised with sodium bicarbonate was injected under the skin of the back of a large frog. In 10 minutes it was absolutely paralysed, the brain and spinal cord were completely out of action. The muscles of the back and trunk and thighs were very white, in rigor mortis, and irresponsive to electric stimulation.

Cajanus indicus—the pigeon pea.

The plant is very extensively grown in Africa and in the East and West Indies. The peas are small with a shiny orange-brown seed-coat. In India they are known as arhar (urhur) and are largely consumed, made into cakes, or boiled with water and spiced, or cooked in hot sand and eaten dry or with salt or oil. In Jamaica they are cooked fresh or dried, and are also used to feed pigeons.

No experiments were made on monkeys but a highly purified extract given hypodermically to rabbits and frogs had the same action as has been described as occurring with other peas.

Commentary.

In all these seeds the poisonous body is an acid and apparently the same acid in all. In large doses its action on frogs is always qualitatively the same, namely, depression of the brain and spinal cord, succeeded, if the dose be not lethal, by more or less increase of spinal reflexes, and the motor nerves are not paralysed. The muscles are also poisoned, more especially in the area of the injection but also more widely through the blood. With very small doses the depression stage may be hardly noticeable and there is an equally slight increase of spinal reflexes.

Rabbits (herbivora) are very insusceptible, but with large doses show a certain amount of weakness of the legs.

In monkeys after a large or frequently repeated smaller dose, the symptoms broadly are those of depression and irritation of the brain and cord, but in detail they vary somewhat. Sometimes drowsiness and lethargy are very prominent, sometimes weak tremors or coarse jerking of muscles, or clonic or tonic convulsions of groups of muscles in rapid succession and involving

the whole body, sometimes a shaking palsy like paralysis agitans. But always there is marked paresis of the motor tracts and muscular weakness. The more powerful flexors and adductors overcome the extensors and abductors giving rise to flexion of the joints and adduction of the limbs. One limb is often earlier and much more affected than the others. The chief effect therefore is on the cerebrum (fore-brain, motor areas and basal ganglia) and the spinal cord, but it is not always the same part which is chiefly affected and hence the considerable variation in symptoms. This is closely comparable to what is seen in man in encephalitis lethargica and in severe chronic mercurial poisoning, and for the same reason in all three, namely, that different areas in the cerebrum may be affected and these areas in varying degree.

A detailed description of the pathological changes which were found in the nervous system of the monkeys which died will be published later and meantime it is sufficient to say that all the peas examined gave rise in monkeys to degeneration of nerve cells and fibres in the brain and spinal cord and that this fully explains the symptoms.

In using fifteen different lots of lathyrus I have found that they vary very greatly in toxicity, and this is probably true also of other peas and accounts no doubt for the cases of poisoning which have occurred occasionally among farm stock with soya meal, and with the bitter vetch and lathyrus itself. My feeding experiment on a monkey with lentils shows that an individual sample of these may also be very poisonous.

The universal experience of mankind is proof that pulses in moderation form pleasant, cheap and nourishing food, and so far lathyrism is the only disease which is known to arise from their use. Short of causing a disease easily recognised clinically the consumption of pulses as the chief part of a dietary may conceivably give rise to some deterioration of health or energy, but I have searched medical literature in vain for any indication of this. It could only occur in communities which are strictly or mainly vegetarian and probably the populations concerned have settled the matter for themselves in normal (non-famine) circumstances by use and wont more satisfactorily than science could do. An interesting question arises as to whether the presence of a nervine stimulant in leguminous seeds has had any influence in determining their almost universal use as a food by mankind. An analogous case is that of caffein, the presence of which in many different plants has led to a general use of these in widely separated regions of the globe from time immemorial. Like opium, coca, tobacco and many other drugs of the same kind these leguminous seeds may be classed as *stimulant-narcotics*, that is, stimulants to the nervous system in small doses and narcotic in large doses, with the difference that they are capable of producing much more readily organic degenerative changes in the central nervous system. Fortunately, however, to do this very large amounts are required. Lathyros, the Greek name for vetchlings, is stated to have its root in θοῦρος (exciting, impetuous), and Cicer, as the Romans called the chick-pea (*C. arietinum*, the Anglo-Indian

gram) is derived from the Greek κίκυς (force, vigour), its ordinary Greek name ἐρεβίνθος having the same significance. Greek and Roman writers on agriculture and natural history and diet refer to and sometimes lay stress on the stimulant properties of pulses both for man and domestic animals, but modern authorities on dietetics seem to have lost sight of this and discuss them only in terms of protein, fat, carbohydrate, calories and vitamins.

EXPLANATION OF PLATE VII.

Fig. 1. Lathyrus: paralysis and flexion of joints.
Fig. 2. Lentils: hypodermic injection of active substance; paralysis, flexion of joints and clonic spasms.
Fig. 3. Lentils: feeding; paresis and somnolence.
Fig. 4. Peas: feeding; paralysis.
Fig. 5. Soya: feeding; paresis and somnolence.
Fig. 6. Peas: feeding; paresis and somnolence.

(*MS. received for publication* 27. IV. 1931.—Ed.)

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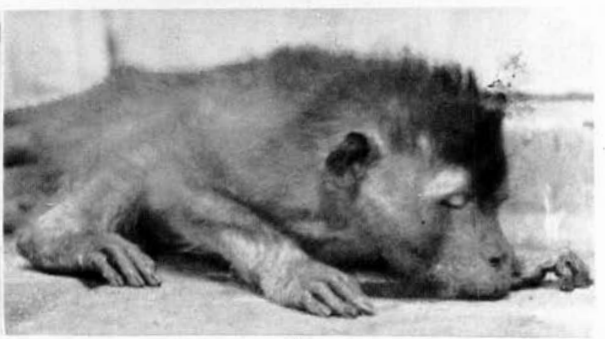

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https://doi.org/10.1017/S0022172400017721 Published online by Cambridge University Press