

# ECOLOGY OF THE RED JUNGLE FOWL IN THAILAND AND MALAYA WITH REFERENCE TO THE ORIGIN OF DOMESTICATION

by

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The Red Jungle Fowl (*Gallus gallus*) is the ancestor of domestic chickens, and one main purpose of this investigation of its ecology in Southeast Asia was to attempt to determine in what ways the species might have been presuited to domestication by early man. Most of our observations were made in Kanchanaburi Province in west-central Thailand during February and March, 1963. A color film illustrating the ecology of the Red Jungle Fowl and some of the interrelations between man and jungle fowl in Thailand was made by the senior author (COLLIAS, 1966), and is available from the University of California.

## Habitat Relations

The Red Jungle Fowl in Southeast Asia is closely associated with the occurrence of primitive agriculture of the shifting cultivation or cut-slash-burn type (Pl. VII, Figure 1). The resulting abandoned clearings are allowed to grow up to secondary forest which is a good habitat for jungle fowl, providing food in the form of rice, tapioca, bamboo and grass shoots, lime from killed snails, seeds and fruits from a variety of small trees and bushes. In Malaya, there are few clearings that have not been caused by human activities (Mr. John WYATT-SMITH, personal communication). By way of comparison jungle fowl apparently do not occur in primal undisturbed forest in Malaya. Dr. H. Elliott McClure told us that during weekly observations over a two-year period from the top of a tall tree in virgin forest near Kuala Lumpur, he never once heard a jungle fowl crowing.



In Thailand the Red Jungle Fowl is generally to be found in bamboo forest, and in fact is sometimes referred to the "Bamboo Fowl" in bird books. Where the elevation of hills rises to a level unsuitable for bamboo we observed no jungle fowl. Thus, jungle fowl were plentiful in the bamboo clumps near our camp in Kanchanaburi Province, but when we climbed up above the bamboos only a few kilometers away, we failed to hear or see any jungle fowl, and our Karen guide, a resident of the area, said that none occurred there. Similarly in the Khao Yai National Park, the engineer helping to build a road up a mountain (Khao Keo) told us that during the course of year in building this road, he only heard jungle fowl crowing when he was living at the camp at an elevation of 3,000 feet but never at the 4,000 foot camp. We noted in walking between these camps that the climbing bamboo (*Dinochloa scandens*) was common at the lower elevation, but there was no bamboo at the higher elevation.

The local people regularly burn the leaf litter in the forest each dry season, apparently to make it easier for them to walk in the forest and to improve the grazing conditions for game. Bamboo is a fire indicator (Mr. Tem SMITNAND, personal, communication) and springs up readily after fire. Fire also stimulates the growth of more stalks per clump according to one of the forest rangers with whom we talked. Jungle fowl are related to fire and bamboo in a number of ways. Burning the ground litter makes it easier for the birds to walk about and the growth of bamboo provides them with a good source of food at a time when most other sources of food are relatively scarce, since bamboo sheds its seeds in the dry season. Most of the jungle fowl we observed, other than at water holes or at roosts, were seen in places where the bamboo (*Bambusa* and *Thyrsostachys*) was in seed at the time.

The black breast and dark tail and sickles of the jungle cock resemble burnt and blackened areas. The bird is much less conspicuous than one might expect when the forest having been burnt is relatively open with good visibility in most places. The bluish-green sheen of the dark sickles matches closely the similar sheen of many burnt places. The jungle hen has a rather dark grey-brown plumage, although it is not black. However, during the dry season when

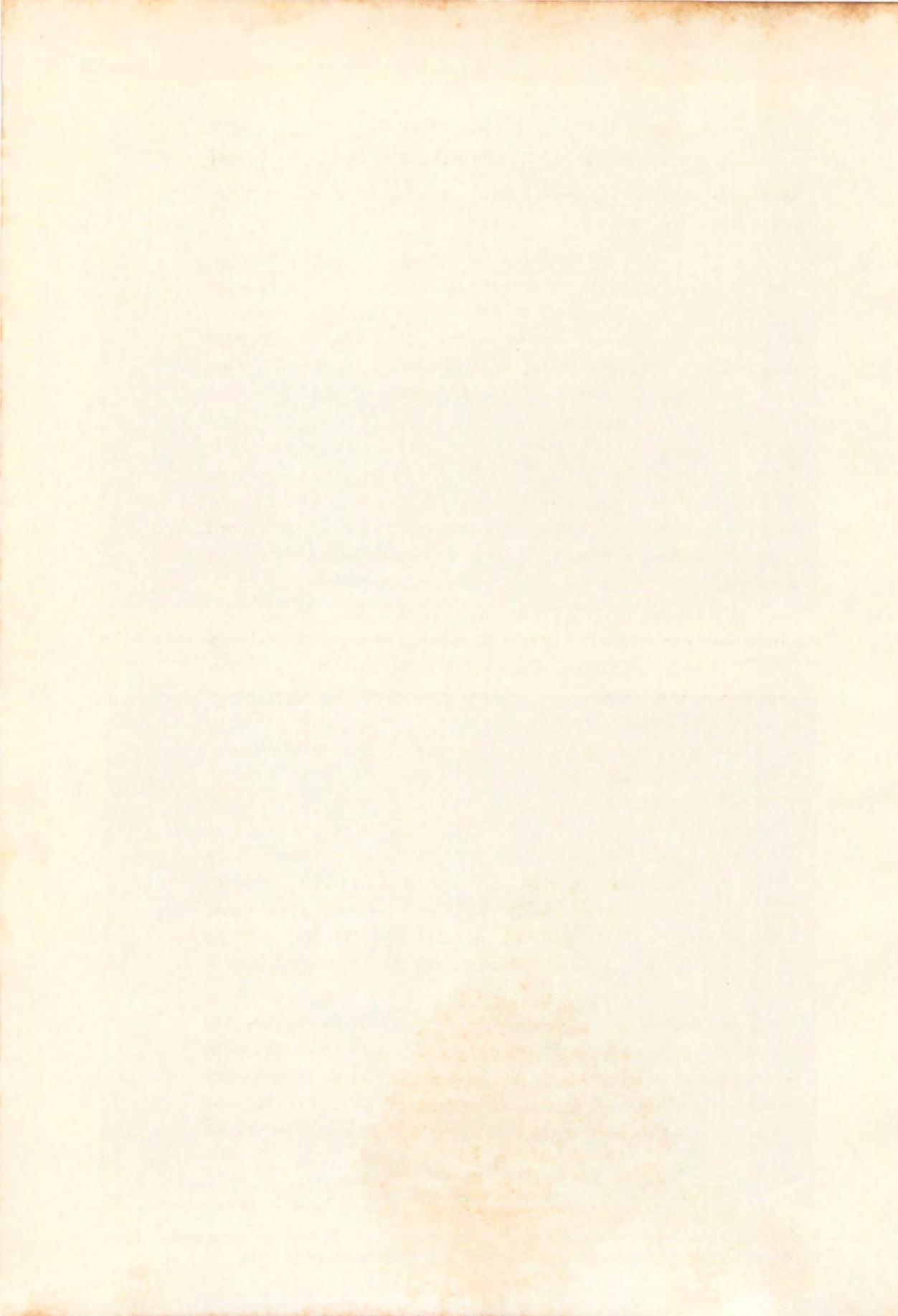




Fig. 1. Recently cut-over clearing for agriculture, next to a Karen hut in the bamboo forest region of Kanchanaburi Province, about 8 kilometers from the River Kwai Noi. (Photog. by N.E. COLLIAS.)



Fig. 2. Wall carving, about 800 years old, of men staging a fight between game cocks. From the Bayon temple ruins at Angkor Wat, Cambodia. (Photog. by N.E. COLLIAS.)





burning is prevalent, the hen is likely to be hidden on her nest and eggs much of the time.

The jungle fowl we observed in Thailand were all in bamboo near the edge of clearings or of former clearings, or near water holes or streams, rather than being uniformly distributed throughout the extensive bamboo forests. Roosting sites were located by means of the dawn crowing and were generally in bamboo clumps and often near dry ravines or water. Thus 6 of 8 roosts located near Lom Sadong at the Khao Salob National Park in the River Kwai Yai region were on the edge of such ravines while the other two were near the edge of a stream. Five roosts located in the River Kwai Noi area were all near water holes. In general, roosts of the different flocks in these two study areas were located one-fourth to one-half kilometer apart. Roosting flocks we observed were small, being ordinarily composed of one or two males and one to several hens.

Water holes where we saw jungle fowl drink were small dry season remnants of streams that at other times of the year would be filled with water. Even at these reduced water holes the jungle fowl preferred to drink from tiny puddles rather than at the larger pools. In 22 hours of observation at water holes in Kanchanaburi Province in the course of photography, COLLIAS saw 21 jungle fowl come to drink. The birds were most likely to come in the morning before 1100; however, quite a few came during the middle part of the day, although none between 1500 and 1700. No observations at water holes were made after 1700. Some other birds that also came to the water holes included White-crested Laughing Thrushes (*Garrulax leucolaphus*), Black-crested Yellow Bulbuls (*Pycnonotus dispar*) and a Green Magpie (*Kitta chinensis*) that chased away the Laughing Thrushes. A pair of Kalij Pheasants (*Lophura leucomelana*) and a Tree Shrew also came.

Our studies were necessarily brief. It would be desirable to study the changing habitat relations of the Red Jungle Fowl throughout the entire year. One of the important needs is to determine whether or not there are seasonal movements of jungle fowl populations. Native tribesmen in the Tenasserim mountain area of central



western Thailand reported to JOHNSON (1963) that "the entire population of jungle fowl moves into the high rain forest, a distance of 5 to 20 miles, during the rainy season, April to November." GILES (1932) had earlier reported observations indicating that populations of jungle fowl in northern Siam in Chiengsen and also in the south part of the country at Phrachuab Kiri Khan may undertake quite extensive movements of at least several kilometers during July. Further evidence for migration by jungle fowl is desirable.

### Food Habits

We were interested in comparing the natural diet of Red Jungle Fowl with some of the nutritional needs of chickens as described by poultry scientists (GRAU, KRATZER and NEWLON, 1956). The contents of the crop and gizzard were analyzed in 23 adult Red Jungle Fowl collected in Thailand. All of these birds were collected in Kanchanaburi Province with the exception of two collected near Pak Chong. The results of analysis are shown in Tables 1 (plant material) and 2 (animal material). A great variety of food is consumed and such omnivorous habits are one more factor predisposing the Red Jungle Fowl to domestication. Besides the food items listed in the tables, the gizzards of the birds all contained varying amounts of fine small hard stones such as bits of quartz that aid much in the comminution of ingested foods, particularly of hard foods like seeds.

Seeds are especially nutritious, those of the *Euphorbiaceae*, for example, *Croton*, being rich in oil and fats. The crop of one cock was almost 3/4 filled with 168 *Croton* seeds. Rice is also eaten. The kernel of rice is largely starch, while the covering is rich in vitamin B, and also contains oil and proteins. Vitamin B is needed for growth in chickens and at Katsetsaert Agricultural University, the chickens are fed on rice bran as well as on broken rice. Bamboo seed is very nutritious and is sometimes used for food by the Karens. We counted 519 bamboo seeds in the crop of one jungle fowl cock collected in the River Kwai Noi area. The Karens told us the best time for bamboo seed to ripen and fall in that area was in the middle of April.

Fruits help provide carbohydrates for energy and in addition their succulence probably helps jungle fowl withstand periods of drought. Besides the several fruits listed in Table 1, our guides reported that jungle fowl eat the fruits of the Krang (*Ficus*), and Wa (*Eugenia cumini*) trees, while we ourselves observed a flock of jungle fowl in a Khoi Pa (*Streblus asper*) tree avidly feeding on the green unripened fruits. Many trees and bushes set fruit at different seasons. In Malaya with its more abundant and better distributed rainfall, some trees like the Luban tree (*Vitex pubescens*) flower and fruit throughout the year. We found fruits of this tree in the crops of two of the three jungle fowl we collected in Malaya.

TABLE 1

Plant contents of crop and gizzard in 23 adult Red Red Jungle Fowl collected in Thailand, February-March, 1963

	Number of birds
<i>Euphorbiaceae</i> fruits (esp. <i>Croton</i> )	6
Bamboo seeds	5
Rice (cultiv.) seeds	3
<i>Zizyphus</i> ( <i>Rhamnaceae</i> ) fruits	3
Maize kernels	3
<i>Acanthaceae</i> fruits	3
Bean seeds	2
Grass seeds	2
<i>Verbenaceae</i> (or <i>Boraginaceae</i> ) seeds	2
<i>Dioscorea</i> bulbils	2
<i>Amorphophallus campanulatus</i> ( <i>Araceae</i> fruits)	2
Pieces of plants stem	1
Insect galls	1

It is customary on poultry farms in America to furnish chickens with greens such as cabbage or lettuce, and a parallel of this in nature is the feeding of jungle fowl on the young tender leaves of bamboo shoots that spring up after an area has been burned.



In Malaya, it was reported to us that jungle fowl eat tapioca roots a great deal, and we did find some tapioca in the gizzard of one jungle fowl. Tapioca, like rice, is one of the characteristic crops of shifting cultivation in primitive agriculture, and, therefore, this dietary habit helps strengthen the attachment of jungle fowl to native clearings.

On domestic poultry farms it has been found necessary to furnish some source of lime to the chickens. The natural analogue of this item for wild Red Jungle Fowl was readily observed in the many shells strewn about burnt clearings where snails had been killed by the fire. About one-third of the birds collected had eaten bits of snail shell (Table 2).

TABLE 2

Animal contents of crop and gizzard in 23 adult Red Jungle Fowl collected in Thailand, February-March, 1963

	Number of birds
Insects:	
Termites ( <i>Isoptera</i> )	12
Ants ( <i>Hymenoptera</i> )	10
Beetles ( <i>Coleoptera</i> )	8
Bugs ( <i>Hemiptera</i> )	4
Flies ( <i>Diptera</i> 3 larvae)	4
Cicadas ( <i>Homoptera</i> )	1
Grasshoppers ( <i>Orthoptera</i> )	1
Roach ( <i>Orthoptera</i> )	1
Spiders	3
Pseudoscorpion	1
Millipede	1
Snail shell fragments	8
Lizard	5



A wide variety of insects is eaten by the Red Jungle Fowl, particularly termites and ants (Table 2). The birds find many insects by scratching away leaf litter on the ground. Half the adult jungle fowl we collected in Thailand had recently eaten termites, while in the crop of one cock we shot in Malaya (Tasek Bera, Pahang District) we counted almost, 1,000 termites (*Macrotermes carbonarius*). It is probable that jungle fowl also obtain termites by breaking up soft newly established colonies or by digging in rotten wood. Termites are often fed to village chickens.

Termites may be especially important as a food for downy jungle fowl chicks. The crops of five downy jungle fowl chicks collected for us in Kanchanaburi Province contained a variety of things, including some seeds and especially insects. Two of these crops contained termites; in one of them we counted 68 termites and 20 rice grains. One of our Karen guides told us the best time for jungle fowl chicks (near Lom Bongti, Kwai Noi area) to hatch was at the beginning of June, and he also maintained that small jungle fowl chicks eat termites as their main food. It would seem that the hatching of most chicks is probably timed to more or less coincide with the more frequent occurrence of termite flights at the start of the rainy season.

Insects are a source of animal protein to jungle fowl which furthermore supplement this need by eating small lizards, such as skinks (Table 2). Many plant proteins are deficient in certain essential amino acids; animal proteins are more adequate in this respect and help balance the diet in chickens.

During the dry season, especially after burning of the forest floor when food is relatively scarce, jungle fowl gain a little sustenance from the dung of large grazing animals where they peck for seeds and dung-inhabiting insects. The crops of some of the jungle fowl we collected contained beetles of the same sort we observed in buffalo dung. Mr. J.A. HISLOP, former Chief Game Warden of Malaya, informed us that herds of the Seladang (*Bos taurus*) in Malaya are frequently accompanied by Red Jungle Fowl, except in deep forest. OGILVIE (1954) mentions that grazing seladang disturb a wealth of



insect life which goes to fill the crops of associated jungle fowl. At Kuala Tahan in the National Park of Malaya he watched a jungle fowl cockerel clean maggots out of a wound at the base of a horn of a cow seladang, so the relationship is not all one-sided.

### Enemies of Jungle Fowl

Man is probably the chief enemy of jungle fowl, at least we always heard and found more jungle fowl in both Thailand and Malaya wherever we got 5 to 10 kilometers away from the nearest village. Mr. Gordon YOUNG, who has wide experience in various parts of Thailand, told us that with the advent of guns among the peoples of the forest, the jungle fowl are fast disappearing near villages. In a study of jungle fowl in west-central Thailand, JOHNSON (1963) came to the same opinion. The Red Jungle Fowl probably always has been much hunted by man, but cannot hold its own against modern weapons.

The wary behavior of the Red Jungle Fowl toward man was the most striking difference in behavior that we observed between jungle fowl and domesticated fowl. When observing the birds from in hiding for purpose of photography, we found they were very sensitive to the slightest movements visible from the hide. In the course of locating roosting sites we observed that once discovered, the birds generally shifted their roosting sites the very next evening and furthermore after a few days of being disturbed greatly reduced or even stopped their dawn crowing. Wild jungle fowl can fly very well, unlike domestic fowl, although like the latter, they often merely walk or run away from a source of disturbance.

Direct evidence on predation of jungle fowl is sparse and generally hard to come by. Our Karen guides told us that hawks, eagles and all sorts of small cats prey on the Red Jungle Fowl, and Boonsee, one of the best informed of these guides, said he had actually seen a Fishing Cat (*Prionailurus viverrinus*) and also a Palm Civet (*Paradoxurus hermaphroditus*) eating jungle fowl. We observed Shikra Goshawks (*Accipiter badius*) and Serpent Eagles (*Spilornis cheela*) near flocks of jungle fowl in Thailand. In west-central Thailand, R.A.



JOHNSON (1963) shot a Yellow-throated Marten (*Martes charronia*) that was trailing a flock of jungle fowl. Certain snakes and monitor lizards may take the eggs of jungle fowl. It is interesting that our guides in Malaya gave us almost exactly the same list of predators as did those in Thailand.

The Red Jungle Fowl in nature may sometimes be infested with internal or external parasites. One hen we collected near the River Kwai Yai in west-central Thailand was parasitized with round worms in her intestines.

Ticks of the genus *Haemophysalis* appear to be specific for birds. On the head and comb of a male jungle fowl collected in the central Pahang district, Malaya, we found the tick, *Haemaphysalis wellingtoni* NUTTALL and WARBOURTON, including 29 examples of male ticks, 5 females, 1 larva and 1 nymph. On the feathers were two ticks of a different species, *H. centropi* KOHLS. Another jungle cock had 12 male ticks, 3 females and 8 nymphs on the head and comb, all belonging to *H. wellingtoni*. This species, originally described from domestic fowl in Borneo, has also been found previously on Red Jungle Fowl by AUDY, NADCHATRUM, and LIM-BOO-LIAT (1960). The female ticks grow much larger than the males and are more of a drain on the host. Whenever the ticks start to metamorphose they drop to the ground and metamorphose in the soil. It seems not to be yet known how they get on the host again.

Another Red Jungle Fowl cock we collected in central Pahang had only one tick (*H. wellingtoni*) on the head, but had many chiggers (larvae of trombiculid mites) on the skin, belonging to the species, *Neoschongastia gallinarum*. This mite is common on domestic fowl, but according to Mr. M. NADCHATRUM, who identified it for us, this seems to be the first record for jungle fowl. This genus is restricted to birds. Unlike ticks which are hard-bodied and parasitic in all three active stages (larva, nymph and adult) chiggers are soft-bodied and parasitic only in the larval state while the adults and nymphs are free-living. The eggs of chiggers are laid in the ground where they hatch and it is not known how the larvae find and attach to the host.

Possibly the opportunity is furnished by the dust-bathing that Red Jungle Fowl, like domestic fowl, engage in.

Four species of bird lice (*Mallophaga*) were collected on the first two Red Jungle Fowl cocks mentioned above. All four species have been previously recorded by EMERSON and ELBEL (1957) from Red Jungle Fowl collected in Thailand and the Phillipines but seem not to have been recorded before from jungle fowl in Malaya. The bird lice on these two birds were identified for us as follows by Dr. R.E. ELBEL:

*Goniodes dissimilis* DENNY: 3 males, 5 females, 3 immatures

*Menopon gallinae* (LINNAEUS): 119 males, 83 females, 43 immatures

*Lipeurus caponis* (LINNAEUS): 1 male, 2 immatures

*Goniocotes gallinae* (DEGEER): 1 immature

*Mallophaga* feed blood and living parts of feathers, and presumably are transferred from one bird to another during times of bodily contact between the birds as during the act of mating or when huddled close together on the roost at night.

### Flock Organization

Our observation of jungle fowl in Thailand was made just prior to the main nesting season of the birds. Thus, of two apparently adult cocks collected, one had the testes fully developed, while another had the testes only about three-fourths of breeding size. Of two adult hens examined, one had completely regressed ovaries with the largest follicles only 2 mm. in diameter, and the other hen had the ovarian follicle slightly more developed but with no follicle more than 5 mm. in diameter. However, JOHNSON (1964) collected a few jungle fowl chicks in west-central Thailand in February. None of the jungle fowl that we personally observed on several expeditions in Thailand during February and March as yet had any chicks and our Karen guides agreed that it was at least one month too early for there to be many chicks in that area.



Table 3 shows the sex ratio in different flocks or subflocks of jungle fowl we saw in Thailand during March, 1963. Most of these birds were observed at water holes (observer hidden) or else at roosting sites; in the latter case more than one person generally participated in the observation. All of the flocks seen were small, and the most common observation was of lone males. Most of the hens seen were with cocks, and in general there were more hens than cocks in mixed groups. In fact, there were no coherent mixed flocks seen that contained more cocks than hens. This discrepant sex ratio must be related to the polygynous habits and to the pugnacity of the males. In his observations, JOHNSON (1963) also found that one of the most common grouping patterns was of a dominant cock with one or more hens, while subordinate cocks were kept at a distance.

TABLE 3

Sex ratio in different groups or subgroups of jungle fowl seen in Kanchanaburi Province, Thailand, March, 1963.

Sex ratio in group	Number of groups
Male : Female	
0 : 1	8
0 : 2	1
1 : 0	12
2 : 0	3
1 : 1	3
1 : 2	1
1 : 3	1
2 : 3	2
2 : 7	1
3 : 6	1
Totals 29 : 36	33

In Malaya, one of our most skilled hunters, Ujang by name, offered some interesting observations. He told us that to his decoy cock usually just one wild cock would come and might have one to

five hens with him, but when he removed the dominant male, i.e., the one with the hens and also the one crowing most often, from a given place, then the other males in that vicinity began to crow much more. The senior author has observed in an aviary at the University of California at Los Angeles that a Red Jungle Fowl male which lost his dominant position virtually ceased to crow while his successor in dominance at the same time began crowing much more frequently than before.

### Domestication of Red Jungle Fowl

The Red Jungle Fowl has been the main and perhaps sole ancestor of domestic chickens (DARWIN, 1887). The plumage of village chickens, such as the "*Gai Jay*" breed in Thailand, often closely resembles that of the Red Jungle Fowl. One of the best ways to tell the wild birds from their domestic descendants that still retain the wild-type plumage, aside from differences in disposition, is that the wild birds have dark slate-gray legs, while the tame birds generally have paler legs (Jean DELACOUR, personal communication). Since dark legs are based on recessive genes (HUTT, 1949), domestic blood quickly shows up in the pale legs of hybrid birds.

The earliest written records of domestic chickens are in the ancient literature of India, but according to PETERS (1913) the Red Jungle Fowl was probably first domesticated in Southeastern Asia and he suggested that the keeping of chickens may have spread into India by way of the Ganges River Valley. He points out "In the earliest stratum of Indian literature, belonging to the Indus period of the Aryan invasion, the Rig Veda, there is no mention of the cock. On the other hand he appears in the Arthava and the Yajur Vedas, which belong to the Ganges period of the Aryan occupation." The domestic and Buddhist cock is then mentioned with increasing frequency both in pre-Buddhist literature belonging to the same general region, the Ganges northward and eastward (PETERS, *IBID.*). The subsequent routes of dispersal of domestic chickens over various parts of the world have been summarized by BALL (1933), WOOD-GUSH (1959) and COLTHERD (1966).



The geographic spread and domestication of the Red Jungle Fowl may have paralleled the spread of primitive agriculture and shifting cultivation, since, as we have seen the creation of clearings for crops helped to increase the extent of habitat for jungle fowl and favored continued association of the bird with man. The original natural geographic range of the Red Jungle Fowl insofar as known (DELACOUR, 1951) coincides with original areas of primitive agriculture and shifting cultivation as mapped by geographers (cf. SPENCER, in press).

Aboriginal people in Malaya often keep all sorts of pets including jungle fowl (Lord MEDWAY, personal communication) and perhaps this habit initiated the process of domestication. On the day of hatching, chicks of the domestic fowl have been shown to have a strong tendency to follow any large moving object, such as a person, especially if he talks or utters low-pitched, brief repeated sounds (COLLIAS, 1952). COLLIAS has also obtained these same results with a newly hatched, captive Red Jungle Fowl chick at Los Angeles. In the course of photography in India, LOWTHER earlier (1949) noted the same tendency to follow a person by two Red Jungle Fowl chicks in nature on the day of hatching.

Mr. and Mrs. John WYATT-SMITH of the Forest Research Institute near Kuala Lumpur appear to have repeated to some degree what may well have been part of the original process of domestication of Red Jungle Fowl. Two females and one male were caught as young chicks, 5-6 weeks old, in the forest, and were fed regularly on rice, being allowed to run freely about the Wyatt-Smith's home. Three additional, wild-trapped jungle fowl were received from the Chief Game Warden, who had kept them in a cage. These three birds were allowed to run with the first three and were fed when they, and these birds bred in the vicinity, being joined by wild jungle fowl from the adjoining forest.

The Wyatt-Smiths eventually turned the birds over to their gardener, MAHMUD. The senior author and his wife visited the Forest Research Institute in November, 1962, by which time Mahmud had obviously acquired some domestic chickens, including a White Leghorn and a Rhode Island Red Cock. The flock now contained an interes-



ting assortment of intermediate types, ranging from the two domestic breeds mentioned to virtually typical wild-type coloration. What particularly interested us about this flock was the close association between degree of tameness of the different individual birds and degree of their plumage modification from wild-type. In addition, the flock as we observed in was still being visited by wild Red Jungle Fowl of both sexes from the surrounding patches of forest. The wild jungle fowl from the forest promptly left the domestic flock and walked or ran to the forest on discovery.

A wild jungle cock typically differed from the semi-domesticated birds in having darker legs (slate gray with a bluish tinge), a large white downy puff at the base of the tail, the back more ruby-red, ear lobes mostly white, comb relatively small and a slimmer, lighter build. A semi-domesticated cock which consistently associated with the flock, closely resembled wild-type, but differed in certain minor respects: dark greenish-gray legs, much less white at the base of the tail, and ear lobes partly white and partly red. It did have the slim, light build of the wild cock, but did not give quite the same impression of extreme alertness. However, this bird was much more difficult to approach than were any of the other members of the flock, and kept avoiding us so we could not get within 100 feet of it.

The Sakai aborigines of Malaya take eggs of jungle fowl hens and hatch them under domestic hens (MADOC, 1956). However, the jungle fowl are likely to wander off into the forest as they mature. A similar practice takes place among the Karens of west central Thailand, as reported to us by Paga, headman of the village of Lom Bongti. He told us that the Karens often bring jungle fowl eggs in from the wild and hatch them under village hens. As the chicks mature they behave like wild birds and go off into the forest, although the cocks may return and mate with the domestic hens. The first hybrid generation also will not stay at the village but offspring of the hybrids crossed back to village birds will do so. Ordinarily, when jungle fowl start separating off from the village flock as they mature, the Karens catch up these birds and use them for food.



Eggs are one of the richest of all natural foods, so it is not surprising that people practicing primitive agriculture in the forest learned to supplement their diet by keeping chickens. A hen continues to lay more eggs when the eggs are removed from her nest. This capacity was much more limited in the early stages of domestication than it is now. HADDON (1945) in an article on poultry-keeping in Bengal stated that the local desi hens gave 40 to 50 eggs a year; with adequate feeding this total could be raised to about 80, while selective breeding could raise their production to about 140 eggs annually. Hens of modern breeds may lay double this number or more each year. Within recent years in Thailand, the poultry industry has increased tremendously with the introduction of modern breeds, the most popular being White Leghorns and Rhode Island Reds. Thus, the numbers of fowl in Thailand rose from 5 million in 1950 to 47 million in 1955 (FRONDA, 1959).

Other uses of the Red Jungle Fowl to early man that might have furthered the domestication of this species of bird were to aid hunting, in magic and religion, and in sport. The use of decoy cocks by hunters is widespread in Southeast Asia. Guides we employed to assist us in locating wild jungle fowl used this technique both in Malaya and Thailand. A cock of the primitive Gai Jay breed or else a hybrid between this breed and a wild bird is often used. It is tethered by one leg to a stake and placed in a good locality for wild Red Jungle Fowl. The decoy on being left alone begins to crow regularly and frequently. From a nearby hiding place we often saw wild Red Jungle Fowl come near the decoy, attracted by the sound of its crowing. Around the decoy a circle of fine, scarcely visible snares are set, in hopes that the wild cock will put a foot through one of the loops when coming to challenge the interloper. However, despite repeated attempts by our guides, involving 4 decoy cocks and 1 decoy hen (with a guide imitating the rally call in the case of the hen) in various places in Thailand and Malaya, we never saw a wild jungle fowl actually caught in the loops, although often these wary birds came very near. A much more successful hunting procedure was for the guide hidden nearby merely to shoot approaching wild jungle fowl.



It seems reasonable to assume that before guns became available to native hunters in the forest that the hunters were much less successful and that jungle fowl had more of a chance of maintaining a population near villages.

Early man in his magic and religion would naturally be expected to make some use of animals with which he was in daily contact. However, it is difficult to know how far back such practices go insofar as the Red Jungle Fowl is concerned or village birds domesticated from it, nor does there seem to be much information published on the subject for Southeast Asia. GILES (1954) has described the secret rites in Siam which involve "reading" of the mouth bones and skin of the head of fowl by the chief priest, foretelling what will happen on a forthcoming elephant hunt. Each hunter is required to bring one or two fowl for this propse.

The sport of game cock fighting is a very ancient one, and is still widespread over the world today. It is a favorite sport in Thailand, where it is probably carried out more like the original practices in that steel spurs or knives are not fastened to the legs of the birds as is often the case in the Philippines. At least none of the birds were so armed at the fights we observed at two different cock pits, one at Pak Chong and the other near Bangkok. In Thailand a special breed, the Gai Chon, characterized by large size, long, strong yellowish legs and much bare skin about the head, has been developed for game cock fighting. The origin of this breed in Thailand seems to be unknown, but judging from plumage coloration of some of the birds, it undoubtedly had root in the Red Jungle Fowl. According to information given us by Dr. Phaithoon INGKASUWAN of the Poultry Department at Katsetsaert Agricultural University, each breeder has his own secret methods.

The fact that game cock fighting has been popular for centuries in southeast Asia is attested to by the depiction of such fights in the wall carvings at the famous temple ruins of Angkor Wat in Cambodia. A photograph, reproduced here, was taken by the senior author of one of the game cock fights in bas-relief at the Bayon temple which is dated approximately 1181-1220 A.D. (Figure 2). On the southwest



wall of the Temple of Angkor Wat, there is carved a group of men staging a fight between game cocks very similar to the bas-relief at the Bayon, but the dates given for this temple in the guidebook are somewhat earlier, 1112-1182 A.D. Came cock fighting in Southeast Asia was probably much more ancient than these dates indicate, judging from records in other parts of the world. In trying to get at the origin of domestication of the Red Jungle Fowl in Southeast Asia, one is hindered by the relative recency of written records from this part of the world. Without doubt continuing archaeological studies will help to fill in the picture in future years.

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### SUMMARY

A field study was made of the ecology and behavior of the Red Jungle Fowl (*Gallus gallus*), with special reference to west-central Thailand (Kanchanaburi Province). A main object of the study was to determine how the ecology of the jungle fowl might have been related to that of early man in such a way as to lead to domestication of this species, the ancestor of domestic chickens. The Red Jungle Fowl was perhaps first domesticated in Southeast Asia where current



habitat conditions for jungle fowl in many places probably still resemble those existing at the time these birds were first domesticated.

Throughout much of the forested country of Southeast Asia in the original geographic range of the Red Jungle Fowl, there has been a prevalence of primitive agriculture of the shifting cultivation type dating back thousands of years. Such cut-slash-burn methods have created clearings, which when abandoned, grow up into secondary forest with bamboo prevalent and represent favorable habitat for jungle fowl, in contrast to unbroken mature forest. The bird is thus predisposed to domestication, since agricultural practices have been creating favorable habitat for jungle fowl near human habitations for many centuries. Even the plumage of the Red Jungle fowl shows evidence of adaptation to the existence of many burnt places in the forest during those time of year when visibility to enemies in the forest is greatest.

The only marked difference we observed between the behavior of the Red Jungle Fowl and that of the Domestic Fowl was in the extremely wary and alert nature of the wild bird. This alert disposition in one sense favors the initial steps in domestication by enabling jungle fowl to maintain dense populations close to villages employing primitive hunting methods, but is ineffective against men with modern weapons.

People living in the forest often keep pets, and the initial step in domestication probably resulted from the close social bond that jungle fowl chicks will form to any large moving object, such a person, gentle contact and repetitive low-pitched sound stimuli (as in human talking) particularly on the day they hatch, when fear responses are relatively much less than later on. Continued survival of such pets would be favored by the hardy nature and omnivorous food habits of the jungle fowl. Domestication was facilitated by the many uses of Red Jungle Fowl to early man. Its relatively large size and that of its eggs furnish an excellent food source, the pugnacious disposition of the cocks provides for the sport of game cock fighting so prevalent in the ancient world, while their habit of frequent crowing readily adapted the cocks for use as decoy birds by human hunters. Other

subsidiary uses, as in religious ceremonies, may also have aided the domestication process.

In the early stages of domestication jungle fowl tend to wander away from the village as they mature and an automatic selection process for the less wary birds must have helped make permanent the association with man. In birds of wild-type plumage a less timid disposition may be associated with the paler leg coloration typical of village birds as against the dark legs of undomesticated jungle fowl of the forest. In the Orient an early type of breed developed was that of game cocks. However, the habit many natives have of bringing eggs of wild hens in from the forest and hatching them under domestic hens probably results in some hybridization and impedes the development of new breeds for other purposes. In the Western world good breeds for egg-laying or meat have been developed, and in recent decades the importation of such breeds into Southeast Asia seems to have greatly increased the heterogeneity in flock of village chickens.

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