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CURRENT MANAGEMENT

The aims of galliforms release and choice of techniques

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Release of Galliformes species is common management practice in Europe and North America. Here, we attempt to synthesise available information on the release of wild-caught and captive-reared galliforms, and discuss how rearing and release techniques affect release success. Galliforms are released into the wild to increase hunted populations with after-hunting-season releases, to establish new populations, to augment threatened populations, and to be used for 'put and take' shooting. We conclude that the release of artificially reared galliforms after the hunting season is not suitable practice to increase an already viable population. Release for 'put and take' shooting is an alienated form of hunting, and it raises ethical questions. 'Put and take' should be strictly examined in the context of wildlife conservation, hunting culture, philosophy and economy. In the case of population establishment and augmentation, translocation of wild-caught birds is by far the best choice. The alternative choice is release of naturally or semi-naturally reared birds and anti-predator trained birds. Galliform release should not be a stereotyped process with many failures, but rather a practice in which correct techniques are used for the pursued aim.

Key words: Galliformes, human dimensions, 'put and take', rearing, re-introduction, translocation

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The order Galliformes includes many species that have significant socio-economic importance for hunting (Martinez et al. 2002). Other species within this order are threatened or endangered (e.g. black-necked pheasant *Phasianus colchicus colchicus*, Attwater's prairie chicken *Tympanuchus cupido attwateri*) and release has been used as a conservation tool for some of these species (Griffith et al. 1989). In Europe and North America, management practices used to conserve or augment galliform populations include habitat improvement, predator control, harvest management and release of reared or wild birds (Arroyo & Beja 2002). Galliforms are normally released into the wild for the following aims: 1) augmenting hunted populations with releases after the hunting season (Haensley et al. 1985, Putaala & Hissa 1998), 2) providing stock for shooting with releases just before and during the hunting season, a practice often known as 'put and take' (Byers & Burger 1979), and 3) establishing populations (introduction, reintroduction) and augmenting threatened populations (Ellis & Anderson 1963, Carpenter et al. 1991, Schroth 1991).

Nestler (1947) reviewed galliform releases and stated: "Undoubtedly pressure in favour of propagation of game birds for liberation will continue despite unfavourable evidence of high cost, tameness and low survival of stock … However, the game-farm epoch in wildlife management, at least so far as public funds are concerned, is probably past its peak, and more attention in the future will be paid to the restoration and improvement of habitat". In spite of this prediction and decades of research and debate, the planning and application of galliform release remain controversial issues (e.g. Gortazar et al. 2000, Robinson 2000, Arroyo & Beja 2002, Musil 2004, Puigcerver et al. 2007). Different aims and techniques exist regarding rearing and release of galliforms, although few attempts have been made to synthesise available information. Therefore, the scope of our paper is to evaluate how different rearing and release techniques affect the success of the pursued aim of release.

Rearing and releasing techniques

Egg incubation and chick nurture can be more or less artificial. It is possible to use incubator and brooder without chicks having contact with adult birds (artificial rearing), and it is also possible to use foster parents which either incubate and nurture or just nurture the chicks after hatching in an incubator (semi-natural rearing). We consider the rearing as natural when eggs and chicks are cared for by their natural parents (Scott & Carpenter 1987, Buner & Schaub 2008).

Artificial rearing is the commonest technique (Game Conservancy 1994). Natural and semi-natural rearing have been used mainly in reintroduction programs (Ellis et al. 1978, Pokorny & Pikula 1987, Carpenter et al. 1991, Schroth 1991, Sannipoli et al. 1992, Slaugh et al. 1992, Melin & Damange 2002, Buner & Schaub 2008). Semi-natural rearing can also include the utilisation of a domestic broody hen *Gallus domesticus*. In this case, egg incubation can be accomplished by hens or incubators (Game Conservancy 1992, Sannipoli et al. 1992, Brittas et al. 1992).

Another technique is the fostering of captive reared chicks to trapped wild birds in the game farm (Ellis et al. 1978, Slaugh et al. 1992) or the field (Buner & Schaub 2008). In some cases, the eggs are exposed to recorded adult vocalisations during the final week of incubation (in the incubator) (Slaugh et al. 1992).

Facilities that utilise large flight pens and plant 'natural' vegetation, spread feed on the ground, minimise human contact, and teach anti-predator behaviour can improve the quality of reared galliforms (Pyornila et al. 1998, Liukkonen-Anttila et al. 2000, Hess et al. 2005). Techniques for teaching anti-predator behaviour have limited application and their investigation began fairly recently (McLean et al. 1999, Griffin et al. 2000, Hess et al. 2005). Examples include reintroduction programs of bobwhite *Colinus virginianus* and chukar *Alectoris chukar*, in which live or fake raptors and hunting dogs were used (Ellis et al. 1978, Slaugh et al. 1992, Angulo 2004). Angulo (2004) used a trained Harris' hawk to prepare white-winged guans *Penelope albipennis* to respond appropriately to aerial predators prior to release. Trained hawks killed chickens in front of the white-winged guan in a semi-captivity cage. Guans reacted positively to this, trying to escape next time the hawk flew over the pen.

Galliforms after release

Artificially reared galliforms

More than half a century ago, researchers demonstrated that survival of artificially reared galliforms in nature was much lower than survival of wild galliforms (e.g. Leopold et al. 1938, Buechner 1950).

Table 1. Total mortality (in %) of artificial reared galliforms at specified time intervals after release. The daily mortality after release is given in the fourth column by use of the equation: DM = 1-[(1-TM)^(1/days)], where DM: daily mortality and TM: total mortality (Heisey & Fuller 1985). The mortality is higher the first days after release, thus, comparison between studies is not possible.

Species	Total mortality (%)	Time interval (days)	Daily mortality (%)	Author
Pheasant	65	7	14	Burger 1964
Pheasant	81-100	30	5-33	Hessler et al. 1970
Pheasant	90	180	1	Burger 1964, Jarvis & Engbring 1976
Pheasant	95-99	365	0.8-1	Robertson 1988
Rock partridge	52-84	21	3-8	Dessi-Fulgheri et al. 2001
Red-legged partridge	25-34	3	9-13	Gortazar et al. 2000
Grey partridge	50	21	3	Birkan 1971
Grey partridge	39-46	25	2-3	Dowell 1990a

Most artificially reared birds die within a few weeks of release (Table 1) and the main cause of the high mortality rate is predation (e.g. Burger 1964, Hessler et al. 1970, Krauss et al. 1987, Robertson 1989, Parish & Sotherton 2007). Behavioural quality of the released birds is crucial. For example, Garson et al. (1992) reported that artificially reared cheer pheasants *Catreus wallichii* roosted on the ground at night and therefore were prone to predation.

Artificially reared birds that survive and enter the reproductive period have poorer rearing success than wild birds. The number of 6-8 week old chicks hatched in nature is 1.69 per wild female pheasant (Leif 1994) and 2.09 per wild female grey partridge (Putaala & Hissa 1998) alive at the beginning of the reproductive period. The corresponding numbers are 0.05-0.4 per artificially reared female pheasant (Jarvis & Engbring 1976, Haensly et al. 1985, Mayot et al. 1991, Brittas et al. 1992, Leif 1994) and 0.05 per artificially reared female grey partridge (Putaala & Hissa 1998). Brittas et al. (1992) reported that on an island where populations of predators were small, the numbers are 2.9-3.2 per wild female pheasant and 1.0-1.7 per artificially reared female pheasant (Brittas et al.1992).

Rands & Hayward (1987) found that of 18 pairs of wild grey partridge, 16 pairs raised chicks. In comparison, of 14 pairs containing at least one artificially reared bird, only seven pairs raised chicks. Hill & Robertson (1988a) found that the number of chicks raised by wild female pheasants was sevenfold greater than that of artificially reared female pheasants. Similarly, wild translocated female pheasants were 23 times more productive (eggs hatched/female) than artificially reared female pheasants (Musil 2004).

The lower reproductive success of reared galliforms is due to predation (Hill & Robertson 1988a, Leif 1994, Rands & Hayward 1987, Putaala & Hissa 1998, Parish & Sotherton 2007) and ineffective exploitation of habitat by the pheasant (Brittas et al. 1992, Sage et al. 2003), something that was not found for the grey partridge (Parish & Sotherton 2007). Sage et al. (2003) also found that the abandonment of nests was a significant problem for artificially reared pheasants in comparison to wild ones.

Moreover, the offspring of artificially reared galliforms that hatched in the wild have inferior survival and reproduction than truly wild birds (Woodburn 2001, Meriggi et al. 2002).

Comparisons between different techniques

Dowell (1990a) released 8-9 week old grey partridges from natural, semi-natural (with hens) and artificial rearing. Artificially reared birds suffered the highest predation, although in some cases, the difference between the three groups was not significant. Dowell observed that partridges of semi-natural and natural rearing and wild partridges roosted in the centre of fields, while artificially reared partridges roosted near field margins. This behaviour increased mortality of the artificially reared partridges, because nocturnal predators moved along field margins. Similar results were found by Merker (1997) with fall-released naturally reared Columbian sharp-tailed grouse *Tympanuchus phasianellus columbianus* that survived better than fall-released artificially reared birds.

Brittas et al. (1992) found no differences in survival of artificially reared and semi-naturally (with hens) reared pheasants. Nevertheless, semi-naturally reared female pheasants had both higher body condition and rearing success than those artificially reared. Artificially reared females nurtured 0-0.4 chicks per female, while semi-naturally reared females nurtured 0.3-1.1 chicks per female (Brittas et al. 1992). Researchers attributed this difference to better feeding ability of semi-naturally reared birds.

In regard to comparison between naturally reared and wild birds, Buner & Schaub (2008) found that the survival tended to be highest in wild indigenous grey partridges, followed by that of naturally reared chicks fostered by wild partridges and followed by that of translocated adult wild birds. While survival of these three groups did not differ statistically, survival of naturally reared adults (without fostering from wild birds) was significantly lower.

Concerning anti-predator techniques, Slaugh et al. (1992) found that semi-naturally reared chukars *Alectoris chukar* exposed to dog and hawk models had higher survival rates than artificially reared birds. However, the authors did not clarify if the higher survival rate was due to the semi-natural rearing or the anti-predator training. For a non-galliform bird species, van Heezik et al. (1999) have reported that the post-release survival of artificially reared Houbara Bustards *Chlamydotis undulata* was improved by exposing them to a live fox before their release.

The aims of release and choice of techniques

Augmenting hunted populations with after-hunting-season releases

Release of artificially reared galliforms has been used to replace losses from hunting. These releases usually take place in late winter and early spring (Haensley et al. 1985, Panek 1988, Putaala & Hissa 1998, Musil 2004). Studies of the success of this practice repeatedly show poor results due to the low survival and reproduction rates (see the previous section). Moreover, Price (1994) reported that a red grouse population *Lagopus l. scoticus* decreased in numbers following releases of reared birds. However, he did not provide explicit evidence that this population reduction was caused by the releases. In Britain, wild populations of pheasant were smaller in number in areas where releases of reared pheasants occurred (Robertson & Dowell 1990), and in Hungary, wild pheasant populations decreased in number as releases increased (Sugár et al. 1996).

Many researchers have reported that the release of reared galliforms can have negative effects on wild populations (Robertson & Dowell 1990, Black 1991, Starling 1991, Leif 1994, Putaala & Hissa 1998, Gortazar et al. 2006). Negative effects may be caused by: 1) decreasing breeding success of wild birds that pair with reared birds (Rands & Hayward 1987), 2) attracting predators (Kenward 1981, Robertson 1988) and enhancing their interest in catching galliforms instead of other prey (Mueller 1971, Costantini et al. 2005); however, DeVos & Speake (1995) did not find increased mortality of wild bobwhites after the release of artificially reared birds, 3) degrading genetics (Sage et al. 2001, Ford 2002, Meriggi et al. 2002), 4) genetic pollution (Barbanera et al. 2007, Barilani et al. 2007, Puigcerver et al. 2007), and 5) increasing prevalence of parasites (Millán et al. 2004, Villanua et al. 2008). The use of medication in reared stocks may leave birds immunologically vulnerable when challenged by pathogens in the wild (Dowell 1992). In a study carried out in Italy, pheasant drops collected in areas where artificially reared birds were released showed a higher prevalence of intestinal parasites compared to areas where only wild populations were present (Mani et al. 2001). Villanua et al. (2008) found that red-legged partridges *Alectoris rufa* obtained from areas where releases take place had higher parasite diversity and intensity than partridges obtained from wild populations.

Moreover, releases may transmit parasites to other species, as in the cases of released pheasants to wild grey partridges (Tompkins et al. 2000), and released red-legged partridges to wild little bustards *Tetrax tetrax* (Villanua et al. 2007). However, Ewald & Touyéras (2002) did not find convincing evidence for a relationship between pheasant release pens and grey partridge population parameters.

Releases may also have indirect consequences through overhunting of wild birds and the neglect of other management practices (habitat improvement, predator control) benefiting the wild population and wildlife in general (Buechner 1950, Robertson & Dowell 1990, Arroyo & Beja 2002).

Several studies using economic criteria have shown that after-hunting-season releases of artificially reared pheasants are not justified as the number of young produced by the artificially reared hens is low (Kabat et al. 1955, Haensly et al. 1985, Musil 2004). Musil (2004) assessed that the harvest produced from after-hunting-season releases is about 30 times more expensive than releasing artificially reared roosters during the hunting season. Moreover, Musil (2004) found that predator control (during spring) did not increase the effectiveness of the practice. Numerous authors argued against releases of artificially reared birds in areas with viable populations of the species (Potts 1986, Hill & Robertson 1988a, Panek 1988, Leif 1994, DeVos & Speake 1995, Putaala & Hissa 1998, Gortazar et al. 2000).

A different option is the after-hunting-season release of translocated wild birds (Musil 2004, Santilli & Bagliacca 2008). This practice is applied in Italy with pheasants captured in hunting prohibited areas, and Santilli & Bagliacca (2008) found that this technique increases the harvest. The cost per captured wild pheasant is about €50-60 (F. Santilli, pers. comm.). In the USA, an estimated $53 per bird was needed to capture wild pheasants in California, and to transport and release them to Idaho (Musil 2004). Musil (2004) assessed that the harvest produced from translocated wild pheasants in spring is at least seven times more expensive than releasing artificially reared roosters during the hunting season.

'Put and take' with releases just before and during the hunting season

The release of reared galliforms to increase immediate harvest opportunity ('put and take') was developed in Britain to support pheasant harvest during driven shoots (Robertson 1989). This practice is now common in Europe and North America (Arroyo & Beja 2002, Connelly et al. 2005). Nevertheless, some hunters oppose the 'put and take' practice (Ratti & Workman 1976).

'Put and take' provides a means of serving harvest demand in areas with relatively dense human populations, small areas of public lands and limited hunting opportunity (Kabat et al. 1955, Greene 1970). Release for 'put and take' requires high numbers of birds, so artificial rearing is usually used to minimise cost per bird (Game Conservancy 1994). However, Baumgartner (1944) and Buechner (1950) reported that the cost of each released bobwhite that entered the bag of a hunter was high due to limited survival after release. Diefenbach et al. (2000) found that the cost of game-farm pheasants in Pennsylvania ranged from $22.63-$90.74 per harvested bird depending on the date and location of release. The corresponding cost in Britain was £18-£33, while the value of a single pheasant at the time of release was £2.5 (Robinson 2000).

Released birds have high mortality (see Table 1), and the potential return from harvest diminishes quickly. Burger (1964) found that of 5,441 artificially reared and released pheasants, hunters harvested 50% of the birds, and 80% of those were harvested during the first week after the release. The remaining stocked birds were mostly killed by predators. Diefenbach et al. (2000) provided similar results for pheasant releases in Pennsylvania, and Thompson et al. (1992) reported 54-67.8% harvest rates for released grey partridges; of this 72.6-84.7% was harvested during the first week after release. Musil (2004) suggested managers to advertise to shooters where birds are going to be released in order to increase harvest.

The short time interval from release to harvest increases the danger of human consumption of harmful substances of veterinary medicines from the meat of released birds. For this reason, Emtryl, a medicine which was used widely in reared pheasants and poultry and that contains a carcinogenic substance with no set safe maximum residue levels, was recently withdrawn by the European Union (Robinson 2000, Davis & Swan 2003).

In some cases, 'put and take' is an economic motivation for landowners to improve habitat and thus benefit nature (Burger 1962, Draycott et al. 2008). Burger (1962) supports that 'put and take' in shooting preserves can absorb considerable hunting pressure from wild populations. Nevertheless, 'put and take' may cause numerous problems in the context of wildlife conservation as in the case of after-hunting-season releases (see the previous section: augmenting hunted populations with after-hunting-season releases).

The 'put and take' practice has also been criticised for being less sporting than the hunting of wild birds (Leedy & Hicks 1945, Allen 1956 cited in Krauss et al. 1987), while for others it lacks 'aesthetic appeal' (Roseberry et al. 1987). Hunter satisfaction for 'put and take' is low when compared to wild bird hunting, as reared birds are easier to shoot than wilds (Ratti & Workman 1976, Byers & Burger 1979). Hunters do not gain satisfaction from killing a quarry, but mainly from the effort expended during the hunting process (Xenophon 430-354 BC, Ortega y Gasset 1942, Causey 1989, Dahles 1993). Vitali (1990) regards the hunter as exercising distinctive human skills, intelligence and virtues such as 'emotional discipline and patience'. Causey (1989) describes the 'sport hunter' as someone who values and enjoys the hunting process: "the drive in sport hunting is to be a link in the chain of nature, connected as predator to prey"; the hunter "regards his prey with admiration, reverence and respect". Leopold (1943) suggested that cultural values of hunting lie in keeping traditions alive, reminding hunters of human origin and dependence on the trophic chain as well as promotion of a land ethic.

On the contrary, 'put and take' is not harmonised with hunting philosophy and tradition (Sokos & Birtsas 2008), and does not promote a land ethic

(Starling 1991). Peterle (1967) found that an Ohio hunter who feels that 'put and take' is the only way to improve his sport was never a member of a social group about nature and athletics, has not read any technical book about wildlife, would kill all the game he could if the legislation permitted it, and feels that hunting is not worthwhile if his hands and feet get cold. 'Put and take' participants give emphasis to the number of harvested birds (Peterle 1967, Greene 1970), thus 'put and take' can be characterised as 'over-consuming hunting' (Sokos & Birtsas 2008). 'Put and take' also drives the transition from hunting to poultry and from hunter to stockbreeder and shooter (Sokos & Birtsas 2008). Furthermore, the above may decrease the social legitimacy of hunting and reduce the lobbying power of hunters (Heberlein & Willebrand 1998, Peterson 2004). For example, some may think that hunting and hunters should be restricted in shooting preserves where 'put and take' is applied.

Moreover, 'put and take' is usually applied within private and commercial shooting preserves (Kozicky & Madson 1966, Kouba 1976, Draycott et al. 2008). This allows visitors interested in released birds to pay for the use of these birds, and it does not obtain public funds and in some cases public lands. However, some exceptions are Cyprus, Hellas, Italy and areas of USA where 'put and take' takes place in public lands with public hunters' funds (Kassinis 1999, Diefenbach et al. 2000, Sokos & Birtsas 2008, Santilli & Bagliacca 2008). In Hellas, public shooting preserves where 'put and take' is applied are government assisted and passive enterprises (Papageorgiou 1996).

Population establishment and augmentation of threatened populations

Efforts to establish populations (introduction, reintroduction) and augmentation of threatened populations are justified when: 1) galliform species disappeared without significant habitat loss, 2) galliform species disappeared due to habitat degradation or loss, but the habitat then recovered thus providing suitable areas for reintroduction, 3) habitat suitability allows establishment of a new galliform species, provided that it does not cause problems for the biocommunity, 4) a galliform population is in danger of extinction (Studholme 1948, IUCN 1987, IUCN 1998), and 5) the changing landscape (i.e. increased fragmentation) currently supports a meta-population based system where small habitat patches experience extinction and recolonisation (Terhune et al. 2006). Release for augmentation of threatened populations needs particular attention because of potential impact on genetics and parasite transmission (Viggers et al. 1993, Hodder & Bullock 1997).

The history of establishing galliform populations is characterised by many failures and few successes (Potts 1986). Efforts using translocations of wild birds tended to be more successful than those involving stock reared in captivity (Griffith et al. 1989, Wilson et al. 1992). In Pennsylvania, the release of 3,000 artificially reared pheasants failed to establish a population, but this was achieved with the release of 1,000 wild pheasants (Myers 1970). Wild birds may cost more per bird initially, but ultimately cost less as they survive and produce more chicks than artificially reared birds (Musil 2004). Many researchers have suggested that the most suitable way to establish or augment a threatened population is by using translocation of wild birds (Leopold et al. 1938, Krauss et al. 1987, Roseberry et al. 1987, Hill & Robertson 1988a, Starling 1991, DeVos & Speake 1995). The utilisation of translocation is proposed in the directives of International Union for the Conservation of Nature (IUCN 1998). However, when the wild source population is small, translocation of birds may create risks (Ellis et al. 1978). In this case, the release of reared birds may be necessary.

A program of rearing and release attracts wide media coverage and is popular with the general public. However, rearing and release may be seen as an easy solution to species decline problems, and the application of other kinds of management practices could be neglected (Starling 1991). Finally, if rearing is judged necessary, the next issue to resolve is the choice of techniques to be used.

Only a few attempts to establish a population with artificially reared birds have been successful (Ellis & Anderson 1963, Starling 1991, Panek 1988, Melin & Damange 2002, Meriggi et al. 2007). Usually, successful establishment is the result of long-term release efforts with high numbers of artificially reared birds, as in the case of a region of Texas, where a population was established after the gradual release of 17,000 artificially reared pheasants during 1968-1980 (Mabie 1980). Many researchers suggest that release of artificially reared galliforms is not an appropriate approach for population establishment and augmentation (e.g. Sexson & Norman 1972, Roseberry et al. 1987, Panek 1988, Hill & Robertson 1988b, Dowell 1990a, Brittas et al. 1992, Slaugh et al. 1992). Moreover, McLean et al. (1999) argued that release of reared animals incapable of surviving in the wild should be considered an immoral act. Thaler (1986) and Dowell (1990b) reported that releases of artificially reared birds should be replaced by releases of birds more capable of surviving, even if they are fewer in number. According to the same authors, this could occur by replacing artificial rearing with natural or semi-natural rearing. A recent example is that of Buner & Schaub (2008) with the natural rearing of grey partridge.

Management implications and future research

Artificially reared galliforms have the lowest survival rates. Survival rates are highest in translocated wild galliforms, followed by or equal to that of birds from improved rearing techniques (naturally, semi-naturally and anti-predator trained). However, published research on improved rearing techniques is limited and further research is needed for the amelioration and evaluation of these techniques.

After-hunting-season release of artificially reared galliforms is not an ecologically and economically effective practice in areas already supporting a viable population of the species. On the contrary, it can cause negative effects to the population and nature in general. In these areas, releases with artificially reared galliforms should not take place.

The cost/benefit ratio is high for after-hunting-season releases of translocated birds, while for birds from improved rearing, this ratio has not been assessed. However, habitat and harvest management seem to be more effective and feasible practices to increase a viable population.

Release aimed at establishing (introduction, reintroduction) and augmenting a threatened population is justified only if certain criteria are fulfilled. In that case, translocation is the best choice. The alternative choice is the release of birds from improved rearing (naturally, semi-naturally and anti-predator trained) as the release of artificially reared birds has low probabilities of success.

The 'put and take' practice should be considered an alienated form of hunting, and it raises ethical questions. There appear to be more disadvantages than advantages for applying the 'put and take' especially if: 1) participants become less conscious about hunting tradition, philosophy and ethics, 2) the percentage of public lands used for 'put and take' is increased, and 3) the hunting demand can be satisfied from existing populations of wild huntable species. For example, in Hellas 60% of land is public and ecosystems have high biodiversity. Also, the hunting is a symbol of freedom and a test of skills. Therefore, the disadvantages of the 'put and take' clearly outweigh advantages. Consequently, 'put and take' should not obtain public hunters' funds and public lands.

For some however, 'put and take' may appear justified in densely human populated areas with degraded habitats and problems with the accessibility of hunters on private lands. In this case, detailed legislative directives must be given, and an environmental impact assessment study should also be carried out in the area of application. Additionally, the use of improved rearing techniques (mainly anti-predator training) may be cost-effective. In regard to research, more knowledge is needed about the transmission of parasites through releases of reared galliforms (especially to other species) and about the human dimensions of 'put and take' in comparison with hunting.

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