THE BIOMECHANICS OF DISTANCE FLYCASTING

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This study examined the differences in the biomechanical elements of two groups of flycasters, (good and elite), when flycasting for distance. Work presented by Krieger (1978), Mosser and Buchman (1880) and Walker (1985) examine the physics of flycasting in relation to flyline dynamics and energy storage of the rod. Kreighbaum and Barthels (1985) analyze the kinetic link principle involved in understanding sequential segmental rotations. Little, however, has been presented that concentrates on the biomechanics of the flycaster and examines the motions of the caster in imparting energy to the rod and line and the mechanics the caster utilizes to smoothly release the stored energy of the rod to the line and fly. We strove to study the mechanics of maximal force application involving both equipment and the caster. The objective of this paper was to determine the differences in biomechanical parameters that enabled elite flycasters to cast for greater distance in comparison with good flycasters.

METHODOLOGY

Experienced flycasters casted for distance utilizing a 9 ft. (2.74 m.), 7 weight medium-action progressive fly rod with #7, weight-forward, floating fly line. The study was conducted indoors to eliminate wind disruption. A white fly rod was used against a black backdrop curtain for maximum contrast and horizontal and vertical reference lines were placed within the filming area. Markers were placed on the casters joints; wrist, elbow, shoulder, hip. knee, and ankle. A system for identifying subject and trial number was also placed in the filming area. Evaluation of casting loop size and other fly line characteristics that occurred beyond the filming arc were visually observed, evaluated and recorded.

The casts were recorded utilizing 2 video cam-corders and the data analyzed using a high quality multi-function; stop action, frame-by-frame, and slow-motion, playback capable V.H.S. recorder.

Twenty experienced distance flycasters were video-taped. Each caster was allotted 15 minutes to familiarize themselves with the fly rod, fly line, and testing

environment. To standardize the procedure each caster was instructed to hold a blackened spot of fly line (16.74 m from the leader) with the line hand. This standardized the amount of line that could be fed into the false casts. Each caster then casted with approximately 14 m of fly line and 2 2 9 m of leader beyond the rod tip. A yarn fly was utilized at the tip end of the leader.

At the end of the practice period each caster made 14 casts, attempting to cast the fly as far as possible. The distance the fly landed from the caster was recorded for each trial and the three most typical and successful casts for each caster were used in our analysis.

Nine of the 20 subjects who casted the fly the greatest distance became our "elite" group. This group included world class tournament casters and renowned teachers and anglers. The 9 casters who achieved the shortest distance scores were designated our "good" group and included expert anglers, tournament casters, and fly casting teachers. The remaining two casters. whose scores fell midway between these two groups were removed from analysis to ensure that the two comparison groups were distinctly different.

RESULTS AND DISCUSSION

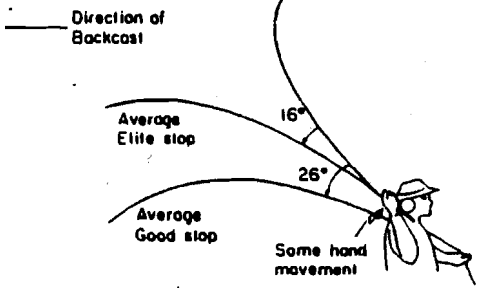
The elite group cast the fly a mean distance of 24.38 m, as compared to a distance of 21.61 m for the good group. It should be noted here, that given their choice of utilizing a heavier stiffer rod and a shooting-taper line each of the casters can cast well over 30.48 m. The findings are grouped into the three sequential stages of the cast: the backcast, the loading of the forward cast, and the unloading or stop of the forward cast.

THE BACKCAST

The casters in this study had to pick-up and control approximately 15.24 m of fly line in the air while false casting, which is the preparatory process of casting backward and forward two times prior to the final cast.

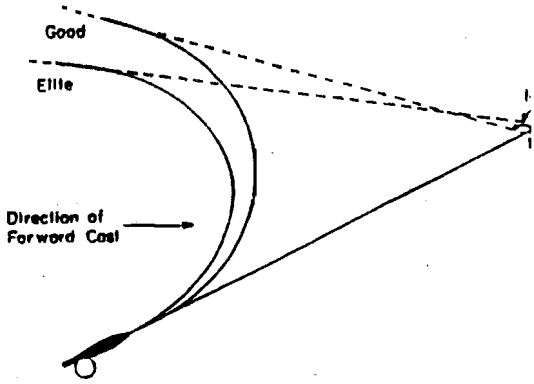
Although the backcast occurs prior to the power application of the forward cast and may not contribute directly to distance, it does serve to straighten the line behind the rod tip. If the line is not almost straight in back when the forward cast begins, it can exert an adverse effect on the distance of the forward cast.

The elite casters straightened the backcast line more completely than the good casters and did so with noticeably smaller loops. We found no differences in the casting arcs of both groups in the backcast. The casting arc is the arc or angle change of the rod butt during the casting stroke. On the backcast, this casting arc was 100 degrees. The mechanic that most affected the line flow was the way the casters stopped the rod at the end of the backcast. The elite group stopped the rod butt more abruptly, moving it an average of 16.6 degrees as compared to 26.7 degrees for the good group, (see Figure 1).



BACKCAST – ROD BUTT STOP

Figure 1.



MAXIMUM ROD BEND – FORWARD CAST

Figure 2.

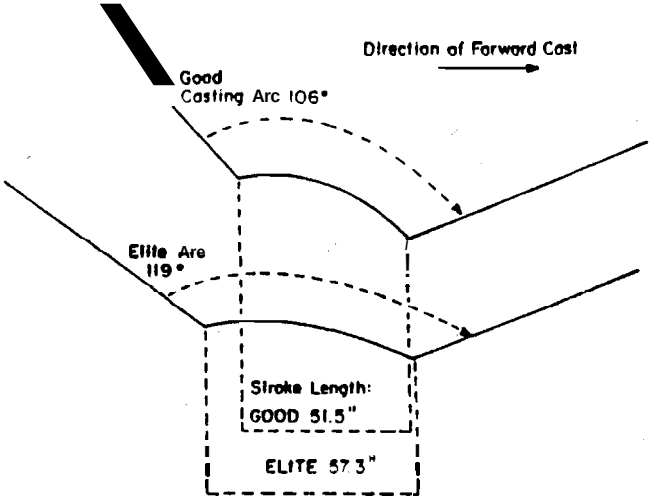
This additional 10 degrees of butt movement allowed the rod tip to drop lower in the back, putting sag in the backcast line and made it more difficult to achieve small efficient loops.

THE FORWARD CAST

When force is applied to the fly rod to drive the line and fly forward, energy is stored in the increasing bend of the fly rod. This is commonly referred to as, "loading the rod." We termed the point of the greatest amount of rod tip bend back from the rod butt, during the forward cast as "maximum rod bend* or deflection, (see Figure 2). The elite group demonstrated a mean of 144 degrees of maximum rod tip deflection as compared to 135.7 degrees for the good group. We believe this to be the most critical variable in casting for distance. Other critical variables are the timing of the point of maximum rod tip deflection and the stopping of the rod on the forward cast. Typically, maximum deflection occurs just before stopping the rod at the end of the forward stroke. When the maximum bend occurs a little early, the rod tip does not follow a straight path during its acceleration. All nine of the elite casters were able to maintain a straight rod tip path while only 2 of the nine good casters were able do so.

The angle of release of the fly line moving from the rod was the same for both groups with a mean release angle of 6 degrees above horizontal.

A difference between the two groups was found in both casting arc and stroke length. The casting arc of the forward cast started when the rod first showed a measurable degree of bend and ended when the rod first began to straighten during the unloading of the forward cast (see Figure 3).



CASTING ARCS AND STROKE LENGTHS- FORWARD CAST

Figure 3.

The elite casters had a wider range of motion with a mean casting arc of 119 degrees as compared to 106 degrees for the good casters. The very best distance casters achieved 130 degrees of casting arc which they accomplished by letting the rod tip drift back an additional 10 to 15 degrees after the backcast had been stopped.

The stroke length is the distance the caster's hand moves the rod butt toward the target as the rod moves through it's arc (see Figure 3). This was measured by utilizing a horizontal reference marker in the film view. The elite casters moved the rod butt an average distance of 1.46 m as compared to a stroke length of 1.31 m for the good group.

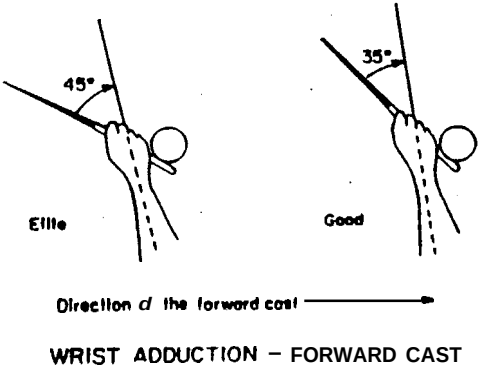
The elite casters made greater use of their body mass and musculature in loading the rod than did the good casters. Six of the nine elite casters used a pronounced weight shift from the back foot to the front foot during the forward cast. Only one of the nine good casters utilized such movement. In addition, the elite group averaged 40 degrees of hyperextension to flexion trunk movement as compared to 30 degrees for the good group. Eight of the nine elite casters demonstrated forward shoulder movement during force application as compared to only four of the nine good casters.

The non-casting hand and arm can contribute to rod bend as the caster "hauls" or pulls on the line during the forward cast. Eight of the elite casters demonstrated highly effective hauls while only three of the good casters achieved such effective hauling movements. The more effective hauls were quick and long in length of fly lines pulled. This added to the deflection of the rod tip. Both p u p s demonstrated similiar amounts of elbow extension, with mean values of 67 degrees of the casting arm. The elite group however, demonstrated 45 degrees of wrist adduction as compared to 35 degrees for the good group (see Figure 4). Most of the 10 degree difference was a result of the elite

casters starting the wrist movement from a more abducted position. The experienced distance casters utilized a late, well-timed wrist action to add to the final acceleration of the rod tip.

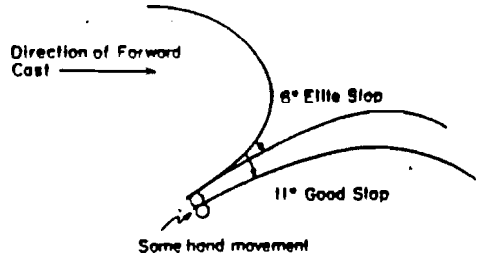
THE UNLOAD OR STOP PHASE OF THE FORWARD CAST

Theoretically, an abrupt stop of the hand and rod butt should direct the release of the stored energy of the rod, through the rod tip to the fly line. Any hand movement or change in rod butt angle during the stop phase represents a softening of the stop movement and involves some release of energy down through the hand This would result in a less efficient utilization of energy stored in the bent rod. We measured the stop in terms of the degrees of rod butt angle change between the point of maximum rod deflection to the point at which the first bends downward. This is when the energy stored in the bent rod is released to the fly line. This is sometimes referred to as the point of turnover. The most successful distance casters stopped the rod so abruptly that the butt moved barely I degree. The elite group restricted rod butt movement to 6 degrees as compared to a mean of 11 degrees of movement for the good group (see Figure 5).



WRIST ADDUCTION – FORWARD CAST

Figure 4.



STOP – FORWARD CAST

Figure 5.

SUMMARY AND CONCLUSION

The elite casters in this study were able to store more energy in the bent rod than the good casters and were able to release that energy more efficiently to the fly line.

The top distance caster in the study; bent the rod the most, stopped it the quickest, used the most body lean. and had among the best rated back casts and widest casting arcs. He hauled the line effectively and kept the rod tip straight during acceleration. He used his weight shift and shoulder rotation to his advantage and benefited from a late. forceful use of elbow and wrist action.

By contrast, each of the skilled casters in the good group had multiple areas that could be improved.

The precise angles and lengths reported here should not be applied in a general manner as they are dependent on the specific fly rod and line used and the casting task of this study. What is important are the kinds of differences observed. It is hoped that in the future, these findings will serve as a basis for more discrete evaluation. utilizing more sophisticated biomechanics equipment.

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